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FINAL CHARACTERIZATION STUDY NSC BASE TANK FARM CNC CHARLESTON SC
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ENVIRONMENTAL SCIENCE AND ENGINEERING. INC.

FINAL
CHARACTERIZATION STUDY
NSC BASE TANK FARM
NAVBASE CHARLESTON
CHARLESTON, SOUTH CAROLINA

Prepared for:
NAVAL FACILITIES ENGINEERING COMMAND
SOUTHERN DIVISION
Charleston, S.C.

Prepared by:

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
Tampa, Florida

86-714

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LIST OF ACRONYMS

BTF	Basse Tank Farm
BTX	Benzene, Toluene, and Xylene
°C	Degree Centrigade
cP	Continental-polar
ESE	Environmental Science and Engineering, Inc.
°F	Degree Fahrenheit
MLW	Mean Low Water
MP	Measuring Point
MSL	Mean Sea Level
mT	Maritime-tropical
NAVBASE	Naval Base South
NAVFACENGCOM	Naval Facilities Engineering Command
NSC	Navy Supply Center
NSFO	Navy Special Fuel Oil
PAHs	Polynuclear Aromatic Hydrocarbons
POL	Petroleum Oil Lubricants
ppb	Parts Per Billion
ppm	Parts Per Million
TDS	Total Dissolved Solids
TRPH	Total Recoverable Petroleum Hydrocarbons

1.0 INTRODUCTION

1.1 SITE LOCATION AND DESCRIPTION

The Base Tank Farm is part of the Naval Supply Center (NSC), Charleston, South Carolina. The NSC Base Tank Farm is located within the central area of Naval Base South (NAVBASE Charleston) of the Charleston Naval Complex. Figure 1.1-1 shows the location of the NSC Base Tank Farm.

The Base Tank Farm is one of the two principal Petroleum, Oil, and Lubricants (POL) storage facilities at NSC. The second primary POL storage facility is the Chicora Tank Farm located approximately one-half mile west of the Base Tank Farm. These two POL facilities store bulk quantities of diesel fuel, Navy Special Fuel Oil (NSFO) and waste oil. The facilities are connected to one another and to Pier K by underground POL transmission pipelines.

1.2 CONTAMINATION HISTORY AND STATUS

Currently, five above ground steel storage tanks are in service at NSC Base Tank Farm. These tanks are identified as 39-A, 39-D, 3900-E, 3900-F and 3901-A. Three additional above ground storage tanks (two made of concrete and one of steel), 3900-G, 3900-H and 39-J, have been disassembled and removed due to continued leaking. A site plan is presented as Figure 1.2-1. Tanks 39-A and 39-D were constructed in the early 1900's, and the remaining tanks were constructed between 1936 and 1944. In 1974, tanks 3900-G and 3900-H began leaking, concurrent with a change in tank use from NSFO storage to Navy Distillate storage. Storage of diesel fuel was attempted in 1975, but the tanks were unable to contain the less viscous fuel. The tanks were taken out of service in 1975.

A leak developed in the bottom of tank 39-J in 1955 and the tank was taken out of service. The tank was lined in 1979, and attempts made to use the tank in 1979 and 1982. However, the tank would not hold fuel.

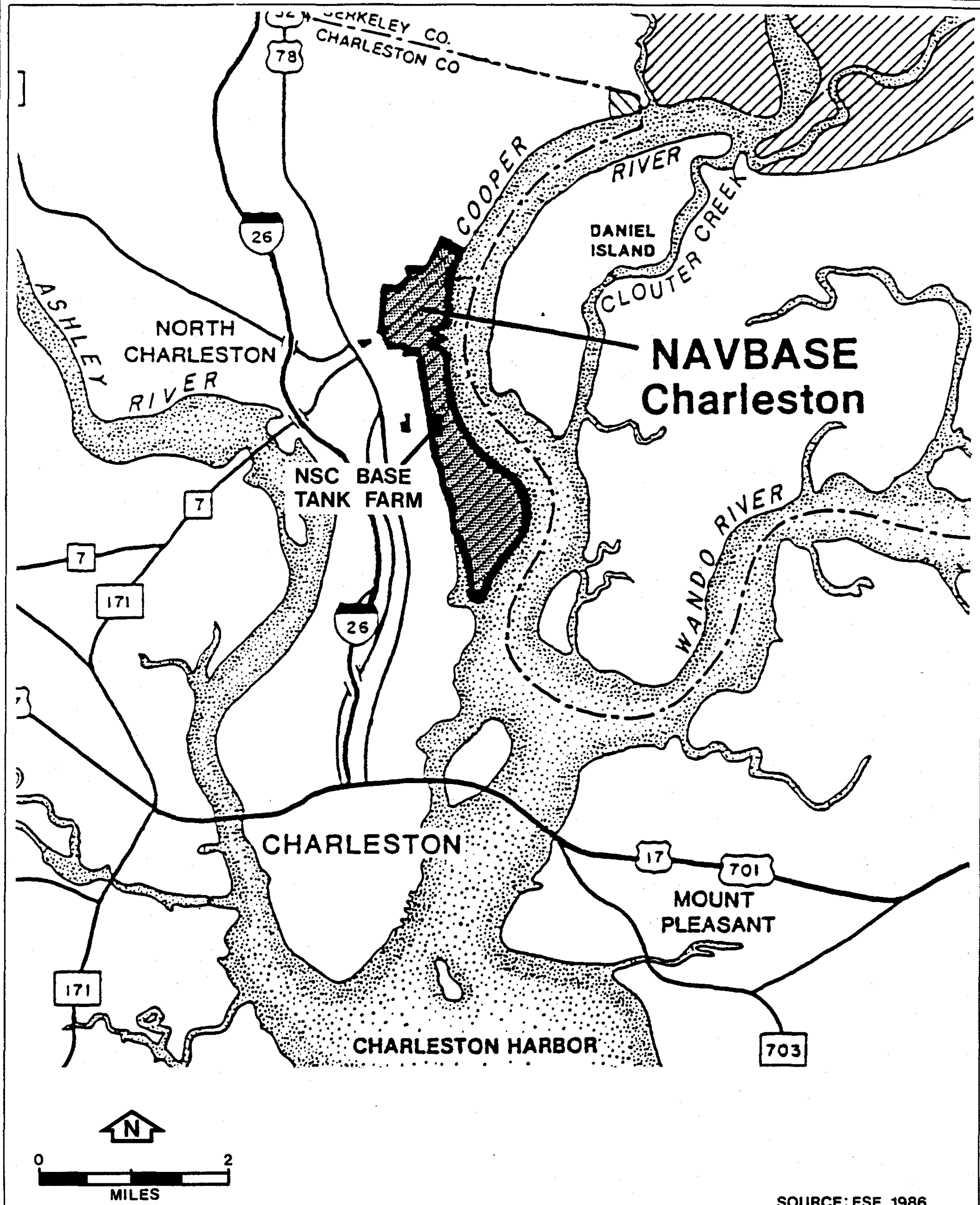
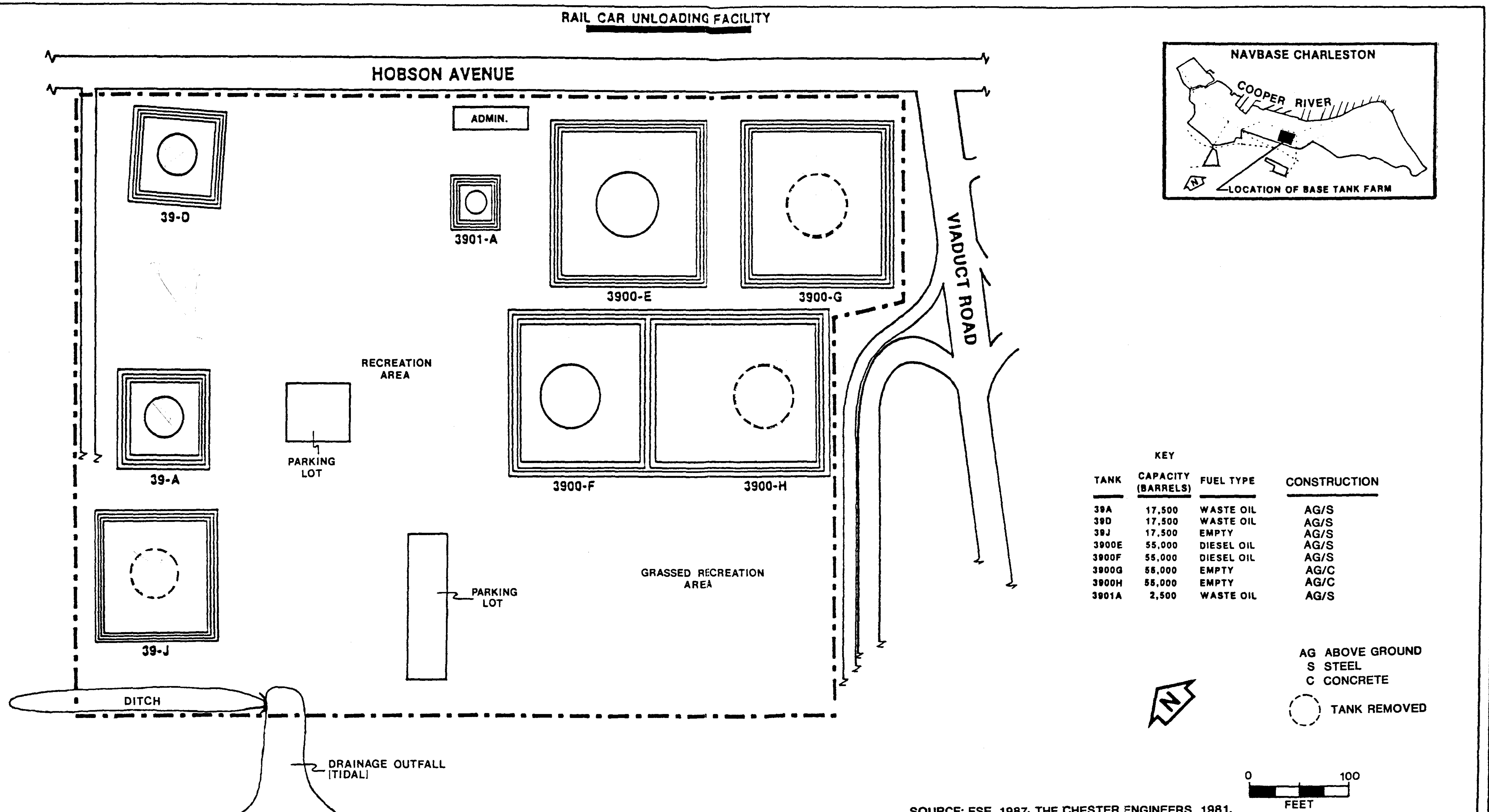


Figure 1.1-1
SITE LOCATION MAP

CHARACTERIZATION STUDY -
BASE TANK FARM
NAVBASE, CHARLESTON, S.C.



KEY

TANK	CAPACITY (BARRELS)	FUEL TYPE	CONSTRUCTION
39A	17,500	WASTE OIL	AG/S
39D	17,500	WASTE OIL	AG/S
39J	17,500	EMPTY	AG/S
3900E	55,000	DIESEL OIL	AG/S
3900F	55,000	DIESEL OIL	AG/S
3900G	55,000	EMPTY	AG/C
3900H	55,000	EMPTY	AG/C
3901A	2,500	WASTE OIL	AG/S

Figure 1.2-1
SITE PLAN

CHARACTERIZATION STUDY - BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

During demolition of tanks 3900-G, 3900-H, and 39-J (February, 1986), the contractor discovered petroleum product in the soils surrounding the tank foundations. Subsequent inspection of the subsurface through shallow boreholes revealed seeping product within 2 feet of the land surface near tanks 3900-G and 3900-H.

1.3 OBJECTIVE AND SCOPE

The Naval Facilities Engineering Command (NAVFACENGCOM), Southern Division, issued Contract No. N62467-86-C-0171 to Environmental Science and Engineering, Inc. (ESE) in May, 1986 to conduct ground water investigations at various locations. The objective of the investigation at the Base Tank Farm is to determine to what extent specific fuels have contaminated the environment in the vicinity of dismantled storage tanks 3900-G, 3900-H, and 39J (storage tank capacities and fuel types which have been stored at NSC Base Tank Farm are listed in Table 1.3-1.). To accomplish the objective, forty-three soil borings were constructed, fifteen soil samples collected, **seven monitor wells installed and sampled,** and three surface water/sediment stations were sampled. The samples were analyzed for benzene, toluene, and xylene (BTX) concentrations utilizing EPA Method 602, and for total recoverable petroleum hydrocarbons (TRPH) concentrations utilizing EPA Method 418.1.

On May 18-19, 1987, the seven (7) ground water monitor wells were resampled and the water table elevations remeasured since drought conditions had existed during the initial sampling program. In addition to the compounds initially analyzed for, the resampling analysis included polynuclear aromatic hydrocarbons (PAHs) utilizing EPA Method 610.

Table 1.3-1 Description of Bulk Storage Tanks in the Base Tank Farm

Tank Identification	Capacity (Barrels)	Fuel Type	Construction
39-A	17,500	WO	AG-S
39-D	17,500	WO	AG-S
39-J	17,500	Empty/Removed	AG-S
3900-E	55,000	D	AG-S
3900-F	55,000	D	AG-S
3900-G	55,000	Empty/Removed	AG-C
3900-H	55,000	Empty/Removed	AG-C
3901-A	2,500	WO	AG-S

D = Diesel Oil
WO = Waste Oil
AG = Aboveground
S = Steel
C = Concrete

Source: The Chester Engineers, 1981

2.0 ENVIRONMENTAL SETTING

2.1 CLIMATOLOGY

Due to the proximity of the ocean, the climate of Charleston is mild and temperate. Daily weather is controlled largely by the movement of pressure systems across the country and by the diurnal effects of the land-sea breeze. Exchanges of air masses are relatively few in summer, when masses of warm, humid, maritime-tropical (mT) air persist for long periods under Bermuda high pressure conditions. Winters are characterized by movements of frontal systems and by replacement of mT air with cool, dry, continental-polar (cP) air.

Average daily temperatures recorded during each month by the National Weather Service at the Charleston Municipal Airport are shown in Table 2.1-1. The coldest month is January, when daily temperatures typically range from approximately 37 to 60 degrees Fahrenheit (°F). In July, the warmest month, the average daily temperature extremes vary between approximately 72 and 90°F. The smaller diurnal temperature variation in summer is due to higher moisture content of the atmosphere on the average day. The record high and low temperatures measured at the airport are 102.9°F and 8.0°F, respectively. Normally, 60 days per year temperatures will be at 90°F or above, while 33 days of the year freezing temperatures will predominate. The average first occurrence of freezing temperatures is 10 October, while the average last occurrence is 19 February, (Army, 1976c; USSCS, 1971; NAVFAC, 1976).

The average annual rainfall in Charleston is 49.2 inches, with a summer peak of more than 7.5 inches occurring in July. The four summer months (June through September) experience more than 50 percent of the annual rainfall. Rain storms during the summer are due to strong convective atmospheric motions, which trigger 72 percent of the average 57 thunderstorms per year. Rainfall during the winter is generally associated with the interface of cP frontal air masses replacing mT air. With the

Table 2.1-1 Annual and Monthly Climatological Data Recorded by the National Weather Service at Charleston Municipal Airport, Charleston, South Carolina

Time Year of Record	Normal Daily Average Temperature, °F Maximum 1947-76	 Minimum 1947-76	Normal Total Precipitation (inches) 1947-76	Prevailing Direction of Winds 1962-76
January	61.2	38.3	2.54	SW
February	62.5	40.4	3.29	NNE
March	68.0	45.4	3.93	SSW
April	76.9	52.7	2.88	SSW
May	83.9	61.8	3.61	S
June	89.2	69.1	4.98	S
July	89.2	72.0	7.71	SW
August	88.8	70.5	6.61	SW
September	84.9	66.2	5.83	NNE
October	77.2	55.1	2.84	NNE
November	67.9	43.9	2.09	N
December	61.3	38.6	2.85	NNE
Annual	75.9	54.5	49.16	NNE

Source: Army, 1976.

exception of the 7 inches dropped during the winter storm of 10-11 February 1973, only traces (less than 0.04 inch) of snow are usually experienced, mostly in January and February (Army, 1976c; USSCS, 1971; NAVFAC, 1976).

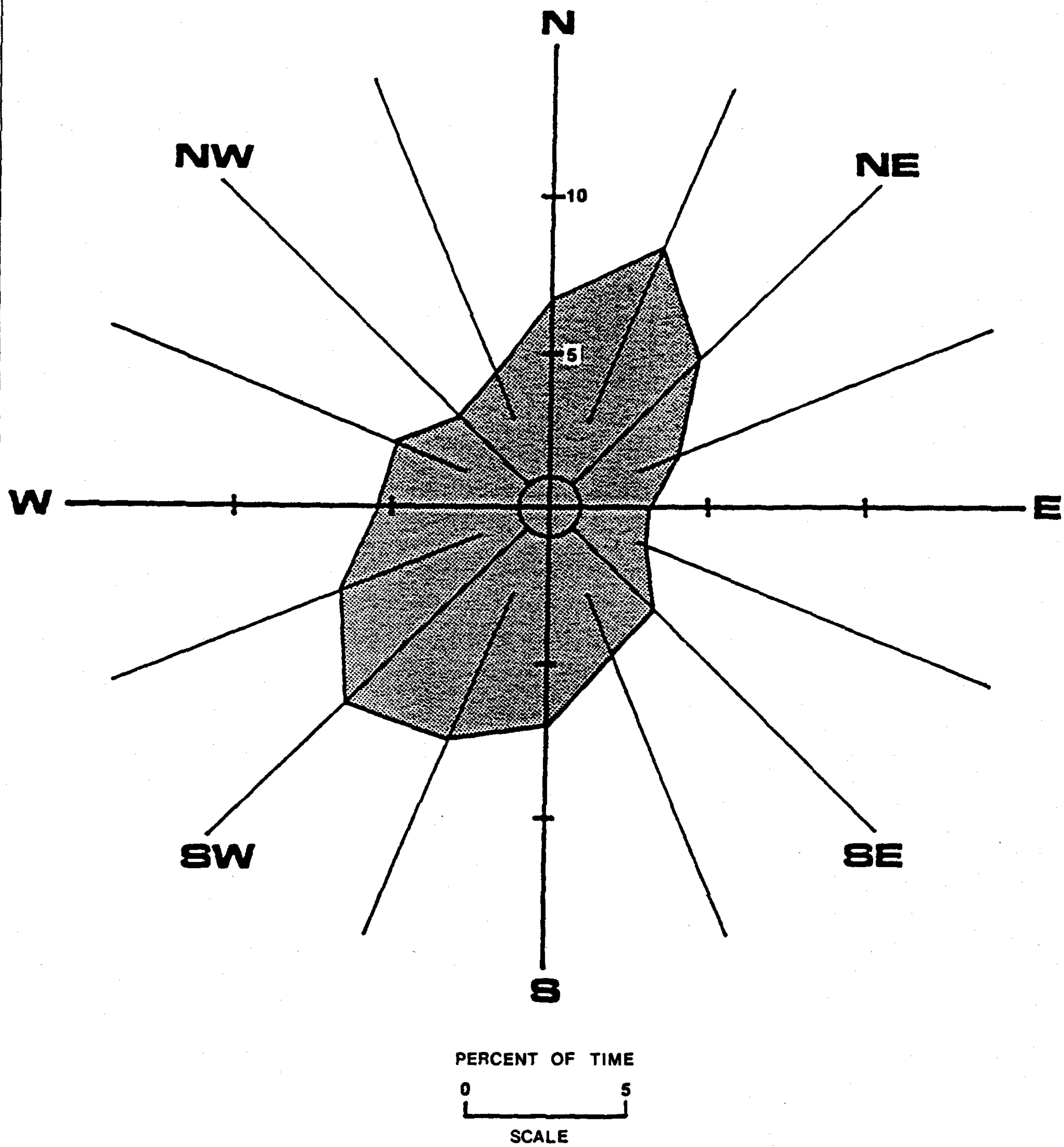
The mean wind speed recorded at the Charleston Airport is 9 miles per hour, with prevailing wind directions (Table 2.1-1) of north-northeast during the winter months and south-southwest during the summer months (Army, 1976c; USSCS, 1971; NAVFAC, 1976). Figure 2.1-1 represents a ten year average wind direction rose for Charleston Airport.

2.2 PHYSIOGRAPHY

NAVBASE Charleston is located on the eastern edge of a low, narrow finger of land separating the Ashley and Cooper Rivers . The topography of the area is typical of South Carolina's Lower Coastal Plain, with low relief plains broken only by the meandering courses of the many sluggish streams and rivers flowing toward the coast and by an occasional marine terrace escarpment. Topography at NAVBASE Charleston is essentially flat, with elevations ranging from just over 20 feet in the northwestern part of the base to sea level at the Cooper River. Much of the original topography of NAVBASE Charleston has been modified by man's activities. The southern end of the base originally was a tidal marsh drained by Shipyard Creek and its tributaries. Over the last 70 years, this area has been filled with both solid wastes and dredged spoil. Most of the base is within the 100-year flood zone, which is below +10 feet mean sea level (MSL) in elevation (ESE, 1981).

2.3 REGIONAL GEOLOGY

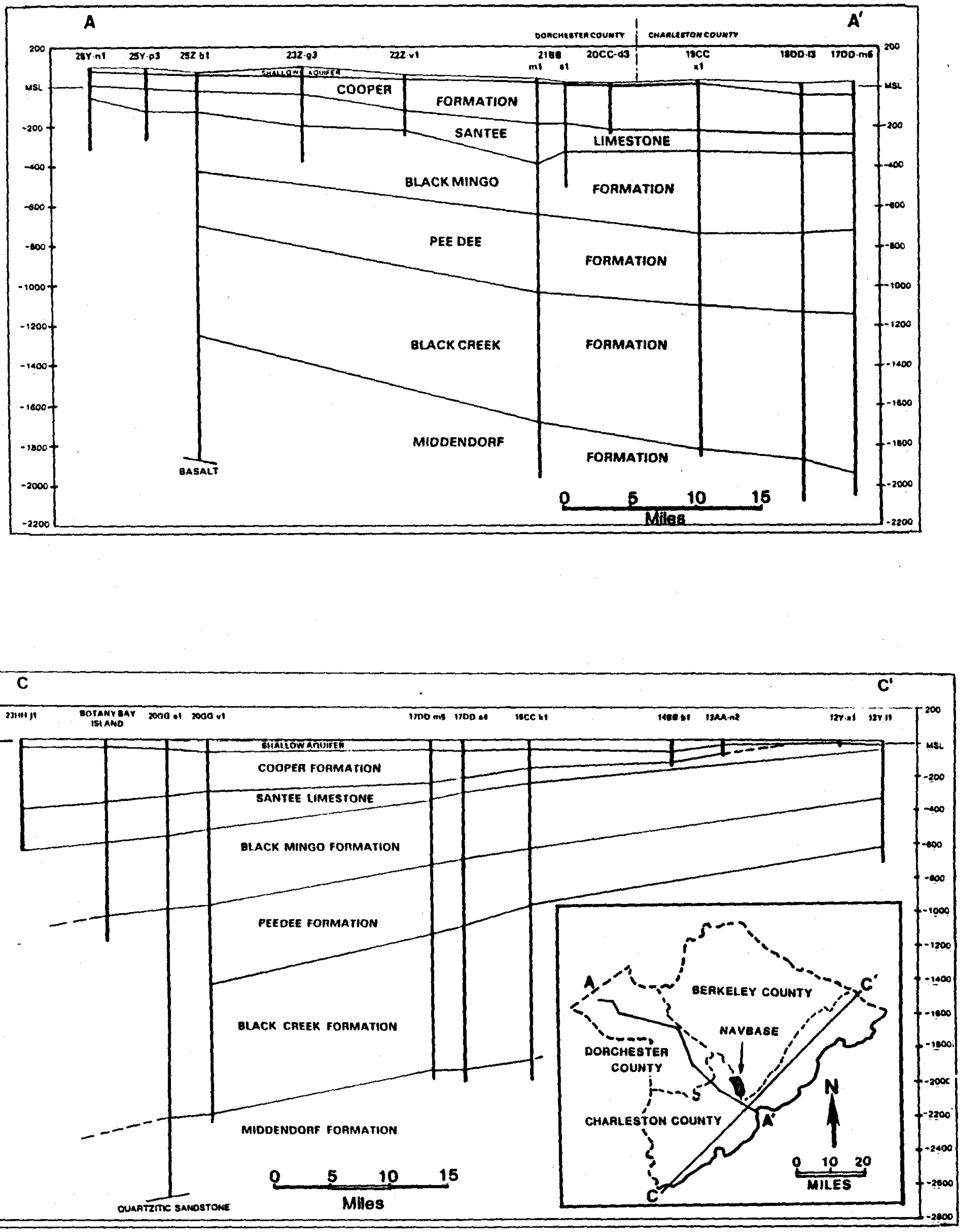
The geology of the Charleston area is characteristic of the southern part of the Atlantic Coastal Plain. A seaward-thickening wedge of Cretaceous and younger sediments is underlain by older igneous and metamorphic basement rock (see Figure 2.3-1). Also, the wedge thins to the south/southeast due to the influence of the Cape Fear Arch.



SOURCES: NAVFAC, 1976.
ESE, 1981.

Figure 2.1-1
TEN-YEAR AVERAGE WIND DIRECTION FOR CHARLESTON AIRPORT, SOUTH CAROLINA

CHARACTERIZATION STUDY -
BASE TANK FARM
NAVBASE, CHARLESTON, S.C.



SOURCES: PARK, 1985; ESE, 1988

FIGURE 2.3-1

REGIONAL GEOLOGIC CROSS SECTIONS

GROUND WATER CHARACTERIZATION STUDY FOR DRMO AREA NAVBASE, CHARLESTON, S.C.

NAVBASE Charleston is underlain by unconsolidated to weakly consolidated Holocene to Miocene clastic sediments, composed of clays, organic-rich clays, silts, and sands (Figure 2.3-2). These materials generally comprise the Talbot Terrace as modified by the Cooper River. The thickness of this overburden is known in detail through the compilation of data from extensive drilling. Overburden thickness in the NAVBASE area varies, ranging form a maximum of greater than 82 feet in a north-northeast-trending depression in the surface of the underlying the Cooper Formation to the immediate west of the Cooper River, to less than 17 feet in isolated areas. Average overburden thickness is approximately 35 feet with thicker zones in the immediate vicinity of Cooper River (Park, 1985).

2.3.1 Regional Hydrogeology

In Charleston County, less than 5% of domestic and municipal water used is from ground water. Over 95% of the water supply for domestic and municipal water consumption is from surface water (Park, 1985). The subsurface hydrogeology underneath NAVBASE Charleston (Figure 2.3-2) consists of the shallow aquifer comprised of surficial sands, silts, and clays of Pleistocene age, which is underlain by the Cooper Formation which acts as an effective regional confining zone. The surficial aquifer is not a source of potable water in the area for the most part; ground water in the shallow aquifer occurs under water table conditions with recharge supplied by local rainfall. The Cooper Formation has a thickness of approximately 200 feet. Underlying the Cooper Formation are the middle aquifers which consist of the Santee Limestone (225-325 ft BLS) and the Black Mingo Formation (325-725 ft BLS). The Santee Limestone exhibits a brackish quality in the Charleston area (Park, 1985) and the aquifer is non-artesian in the Charleston area (Park, 1985). The Black Mingo formation contains an artesian aquifer which is more brackish than that of the Santee Limestone. Inter-aquifer transfer between the Santee Limestone and the Black Mingo formation aquifers in the open hole boreholes of the local domestic wells is common. Brackish water quality

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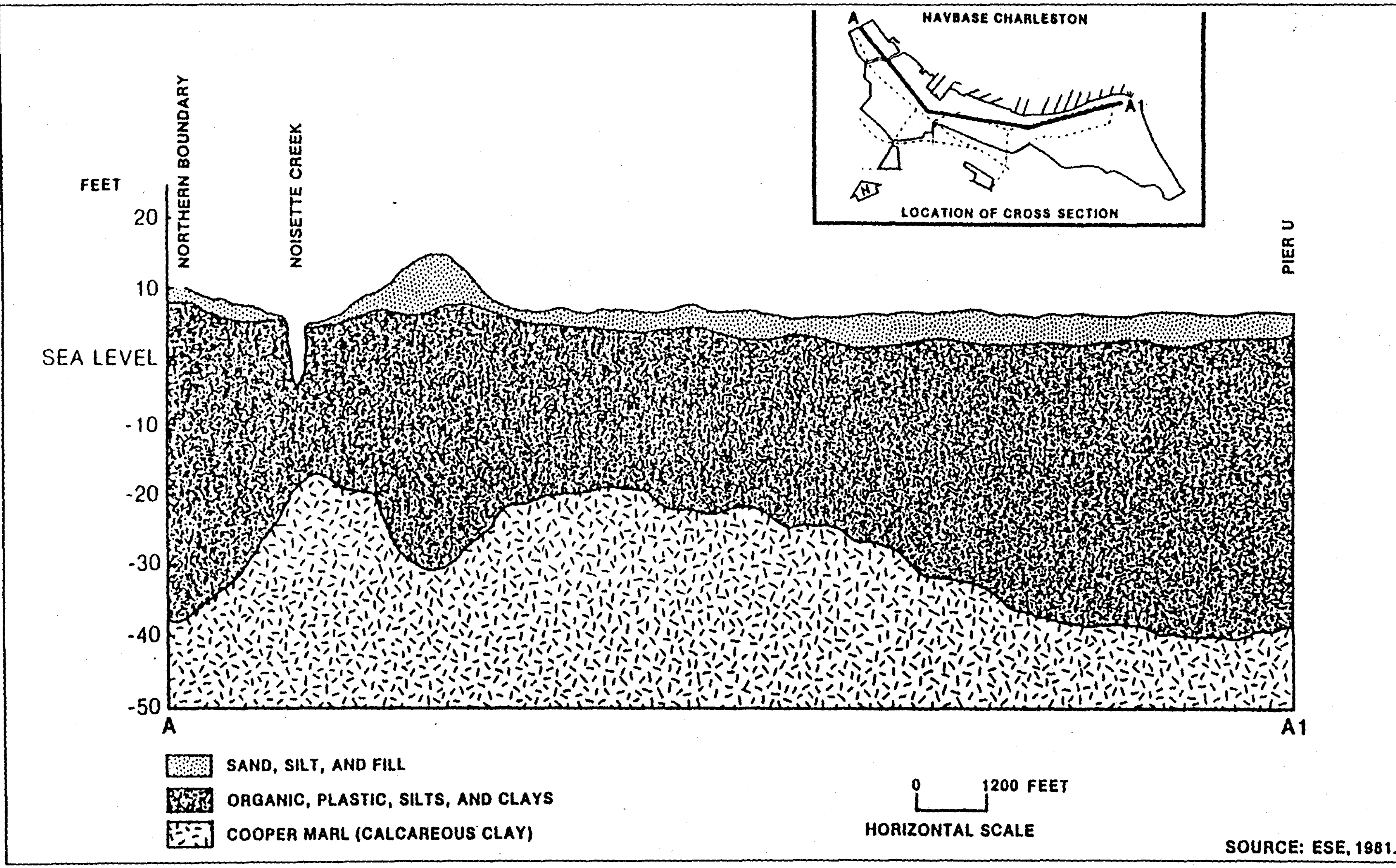


Figure 2.3-2
GENERALIZED GEOLOGIC CROSS SECTION
THROUGH NAVBASE CHARLESTON

CONTAMINATION ASSESSMENT
FOR THE CHICORA TANK FARM
NSC, CHARLESTON, S.C.

is accepted as the norm in these wells (Park, 1985). The Middendorf Formation (below 1,900 ft) contains the principal aquifer of the Carolina coastal plain. Its Brackish quality and deep depth makes it an unsuitable water source in the Charleston area. It is artesian in the Charleston area (Park, 1985).

2.4 SURFACE HYDROLOGY

Runoff at the site is collected southwest of the tank farm and flows northeast, entering the farm area directly south of tank 39-J. The canal is wide and shallow southwest of the perimeter fence, and supports sparse to moderate growths of aquatic and transitional grasses and plants at the littoral zone. Towards the base farm perimeter fence, the canal narrows substantially, while becoming deeper and less vegetated. A culvert directs the flow underground and continues in a northeast direction eventually connecting with the Cooper River. Velocity and direction of the flow are influenced by tidal changes occurring in the Cooper River. At the time of sampling, the flow was traveling northeast towards the Cooper River, a flow traveling southwest was observed after the sampling effort due to tidal influence.

A ponded canal exists directly northwest of the underground outfall culvert of the main drainage outfall. This canal is oriented in a perpendicular fashion to, and drains southeast directly into the main drainage canal via a culvert. The small canal collects runoff from the immediate surrounding areas composed of mostly grass and bare soil/rocks. Little vegetation exists at the peripheral or littoral zone of the small canal. Section 3.3 describes the surface water/sediment sampling location at the major drainage outfall adjacent to the site.

3.0 INVESTIGATION METHODOLOGY

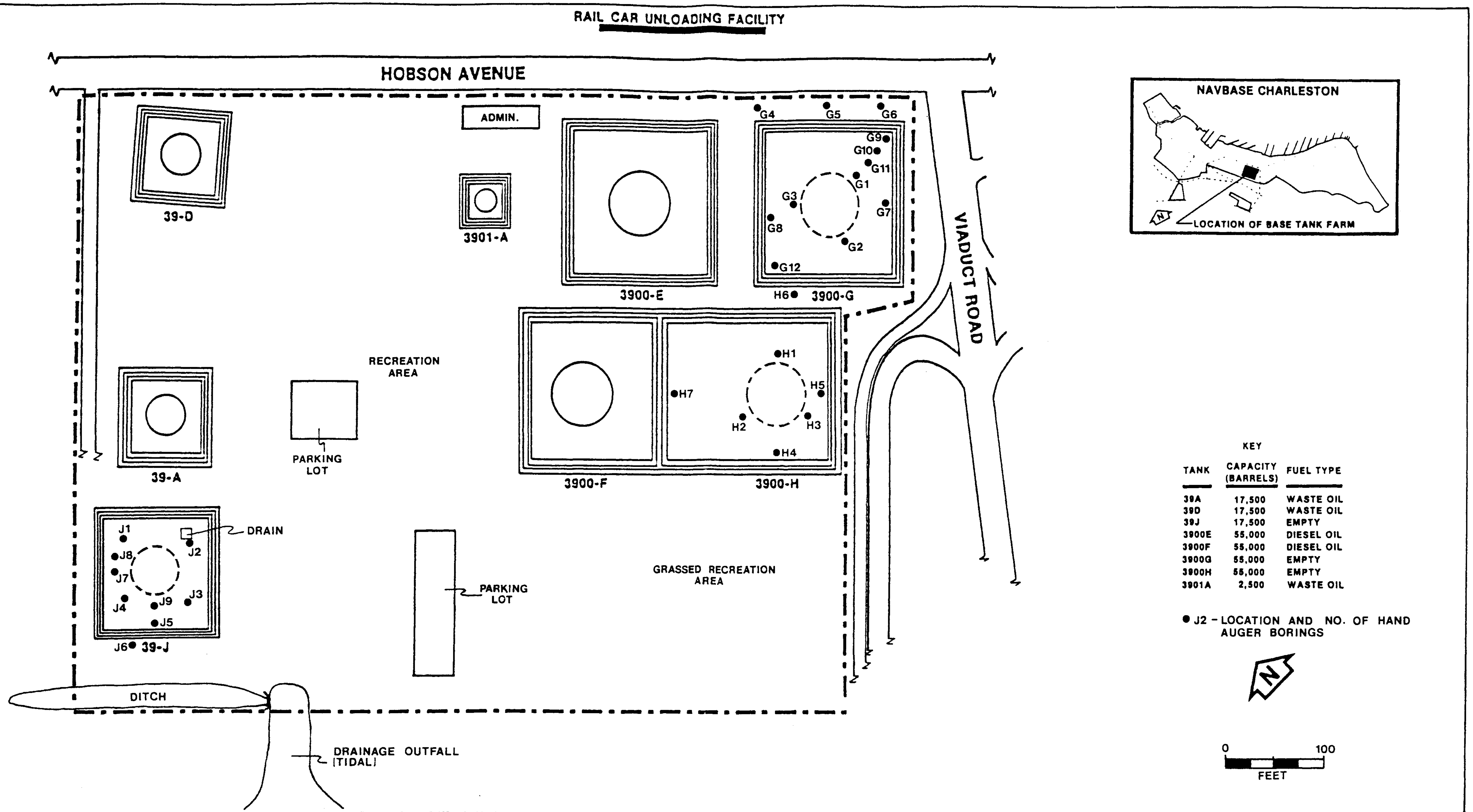
3.1 SOIL SCREENING AND SAMPLING

During the period from July 29 to July 31, 1986, a total of 43 shallow soil borings were constructed at the NSC Base Tank Farm. These borings included 28 exploratory borings and 15 additional borings to acquire soil samples. The borings were constructed to depths ranging from 2.5 feet to 6.5 feet below land surface using a 2-man power auger. Soil borings and soil sampling locations are shown in Figure 3.1-1 and Figure 3.1-2, respectively. Decontamination procedures, enumerated in the work plan, were followed in the field investigation. The portions of the auger/sampler which contacted the soil were cleaned between each sample collected by wiping and brushing all visible soil away, followed by a rinse with trisodium phosphate solution and laboratory distilled water. A portable, pressurized sprayer was used to apply the water rinse. Prior to the collection of each sample, the auger flight and bucket sampler were plunged into the matrix adjacent to the sample point to abrade any residual from the previous sample as a final preparation.

The twenty-eight borings were constructed to identify areas of gross contamination prior to sampling (see Figure 3.1-1). These soil borings were inspected for **visual and olfactory** evidence of hydrocarbon contamination. Fifteen additional soil borings were constructed for the purpose of acquiring soil samples after the initial screening was completed (see Figure 3.1-2). Analytical results for these soil samples are reported in Section 5.1. Soil boring logs are included in Appendix A.

3.2 MONITOR WELL CONSTRUCTION AND SAMPLING

Seven permanent ground water monitor wells were constructed at the NSC Base Tank Farm from July 28 to July 30, 1986. The locations of the new monitor wells are shown on Figure 3.2-1. Each well was constructed by the hollow stem auger method using 4-inch inside diameter (6-inch outside diameter) auger flights. All drilling equipment was decontaminated between each boring by steam cleaning, spraying with deionized water, and



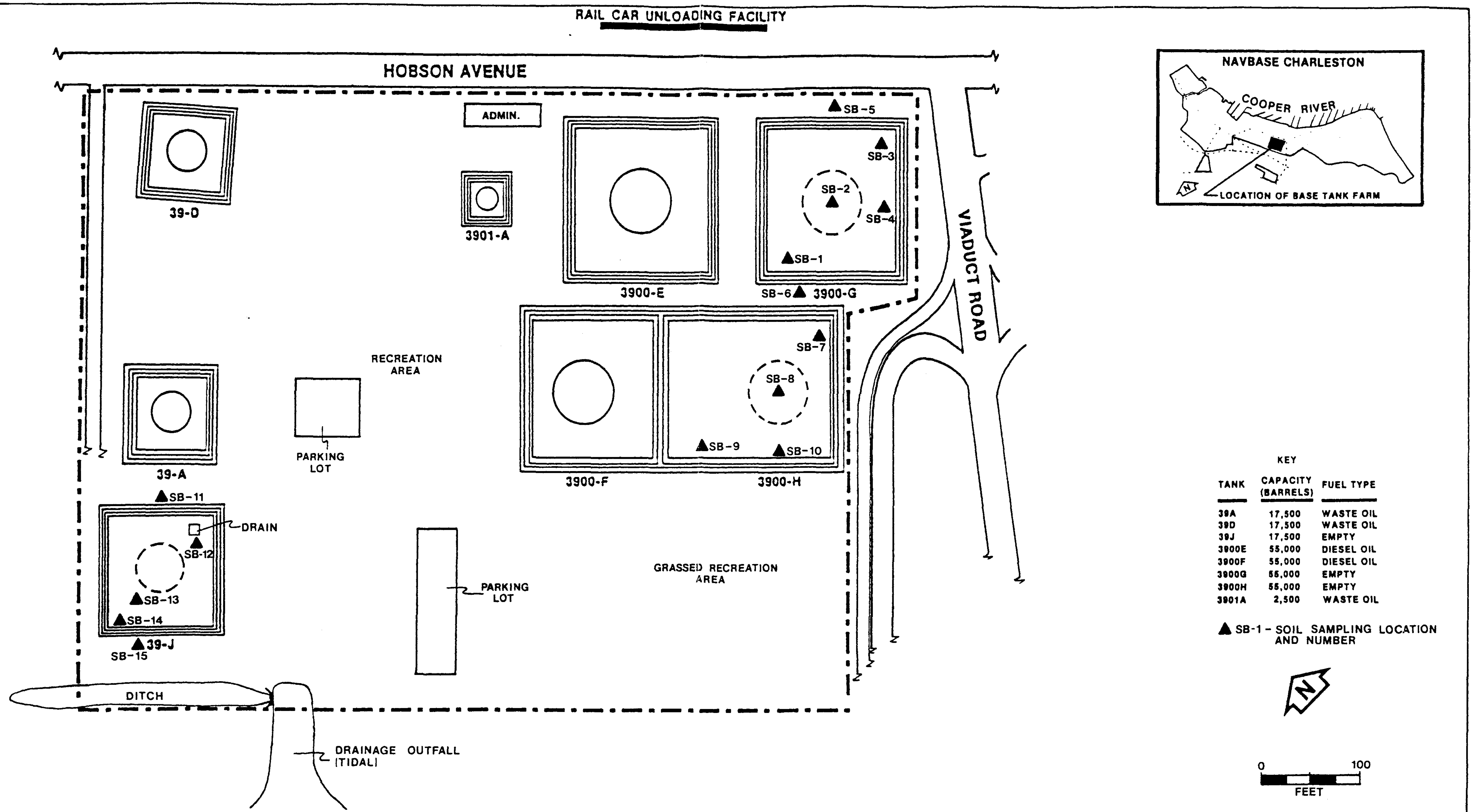
KEY

TANK	CAPACITY (BARRELS)	FUEL TYPE
39A	17,500	WASTE OIL
39D	17,500	WASTE OIL
39J	17,500	EMPTY
3900E	55,000	DIESEL OIL
3900F	55,000	DIESEL OIL
3900G	55,000	EMPTY
3900H	55,000	EMPTY
3901A	2,500	WASTE OIL

● J2 – LOCATION AND NO. OF HAND AUGER BORINGS

Figure 3.1-1
LOCATIONS OF HAND AUGER BORINGS FOR PRE-SAMPLE SCREENING

CHARACTERIZATION STUDY -
BASE TANK FARM
NAVBASE, CHARLESTON, S.C.



TANK	CAPACITY (BARRELS)	FUEL TYPE
39A	17,500	WASTE OIL
39D	17,500	WASTE OIL
39J	17,500	EMPTY
3900E	55,000	DIESEL OIL
3900F	55,000	DIESEL OIL
3900G	55,000	EMPTY
3900H	55,000	EMPTY
3901A	2,500	WASTE OIL

Figure 3.1-2
SOIL SAMPLING LOCATIONS

CHARACTERIZATION STUDY -
BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

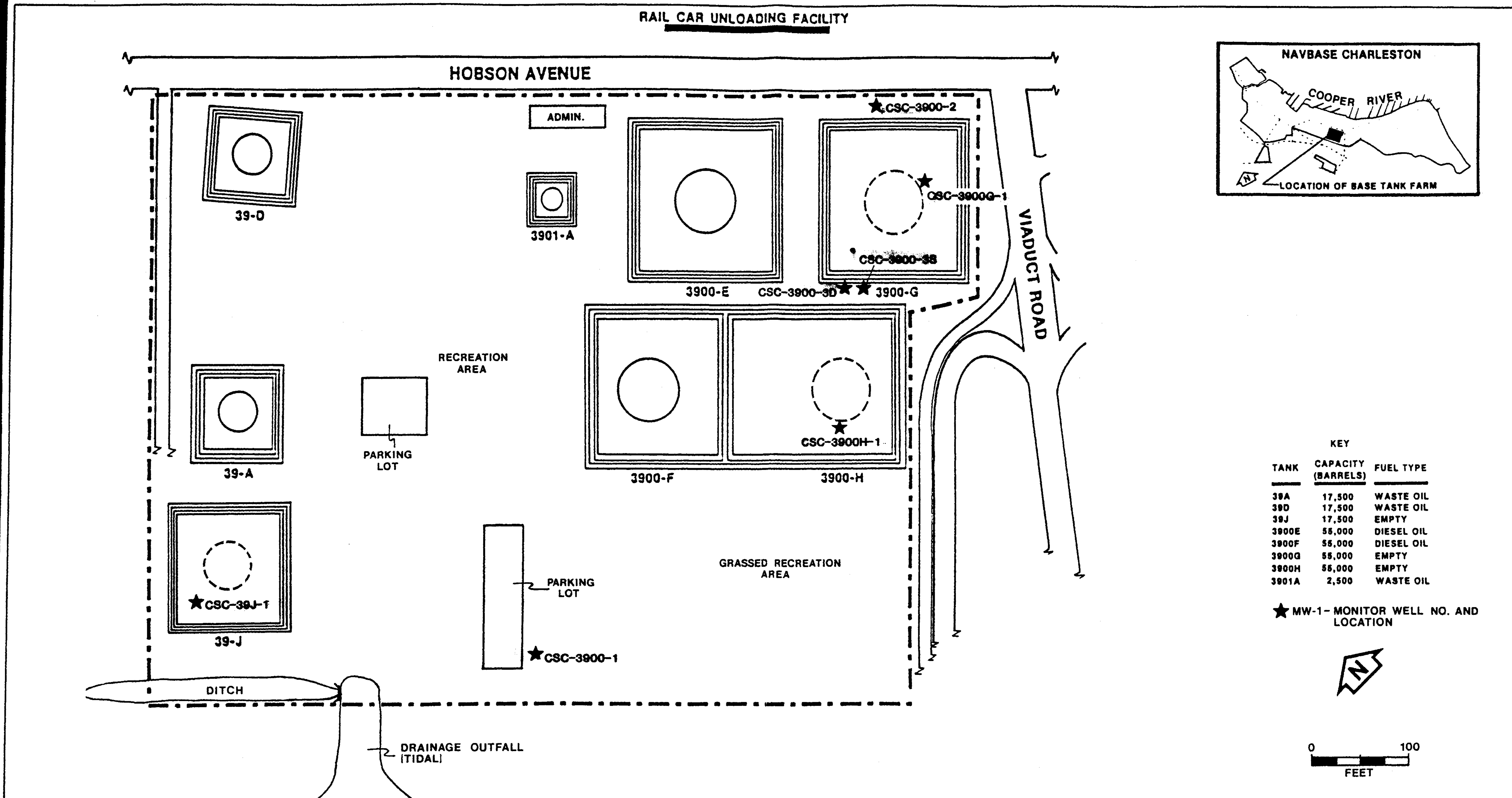


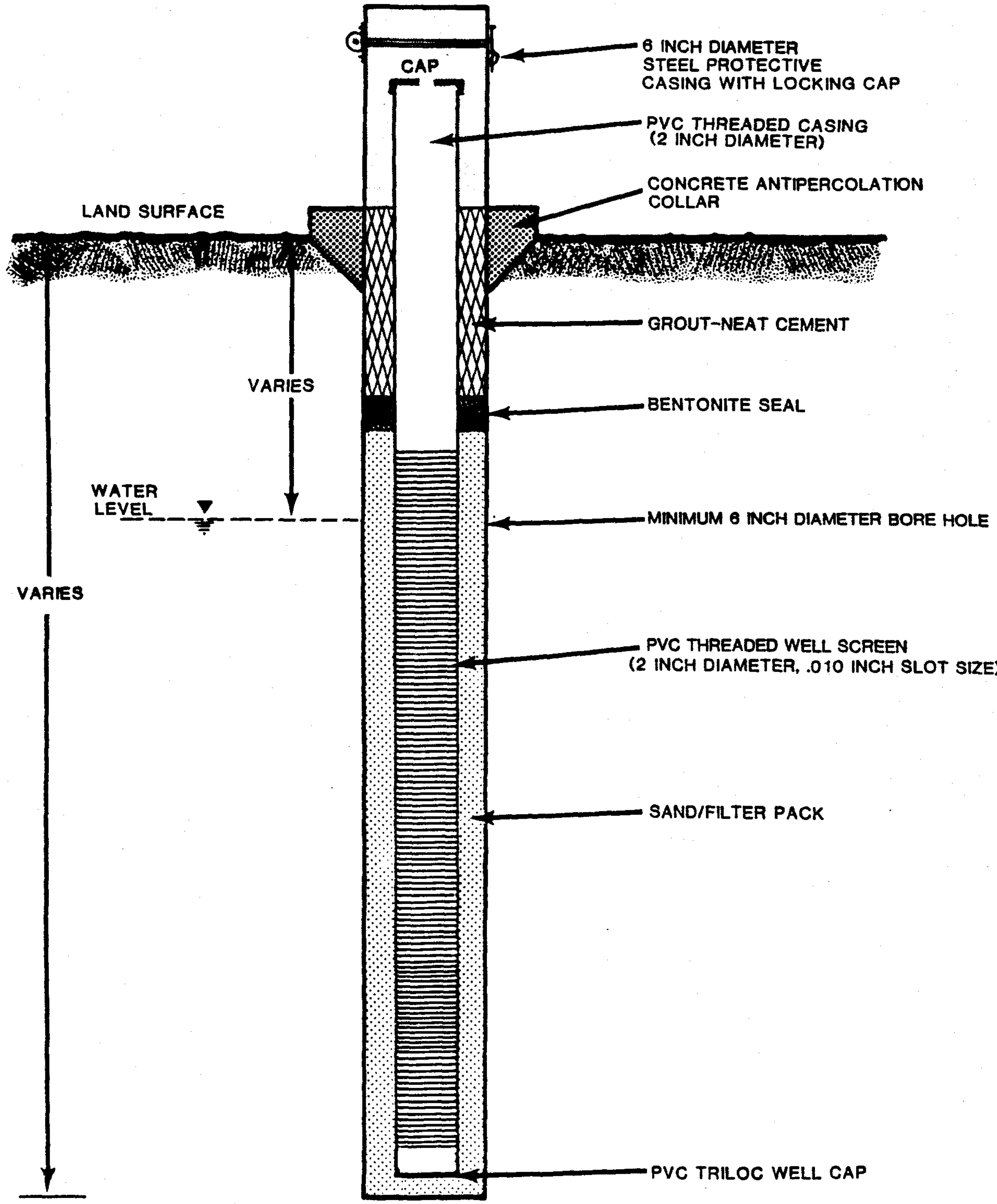
Figure 3.2-1
MONITOR WELL LOCATIONS

CHARACTERIZATION STUDY -
BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

rinsing with isopropanol. The boreholes were completed to depths of approximately 15 to 25 feet BLS. The auger boring and well construction was supervised and logged by an ESE hydrogeologist. Boring logs and monitor well completion reports are included in Appendices B and C, respectively. Each monitor well was constructed with approximately ten feet of Schedule 40 PVC, 0.010-inch slot size, threaded well screen, and approximately five to fifteen feet of Schedule 40 PVC, threaded riser pipe. The wells were constructed by setting the PVC well screen and riser pipe within the hollow stem augers. A clean silica sand pack was installed in each annular space, from the base of the screen to approximately two feet above the screen as the hollow stem auger flights were retracted from the borehole. A one foot thick bentonite seal was placed in each annular space above the sand pack. The remaining annular space was filled with a neat cement slurry to land surface. Each monitor well head was completed with a locking protective steel casing set into a concrete antipercolation collar. Following construction, each well was developed until the discharge water was reasonably clear and silt free. All of the monitor wells were developed by the hand bailing method with dedicated PVC bailers, with the exception of Monitor Well CSC-3900-1, which was developed with a centrifugal pump. This was the only monitor well capable of producing a sufficient amount of water to pump continuously. A typical monitor well construction diagram is shown on Figure 3.2-2. Table 3.2-1 lists construction details for the new monitor wells. Individual monitor well construction details are presented in Appendix C.

An elevation survey was performed by the South Carolina registered NAVBASE surveyor. Measuring point (MP) and land surface elevations in reference to mean low water (MLW) were obtained for each monitor well location. This elevation data is presented on Table 3.2-2.

Prior to sampling, the new monitor wells were allowed to equilibrate for eleven days. Each monitor well was sampled on August 11, 1986. Prior to sampling, monitor wells CSC-3900-1, CSC-3900-2, CSC-3900-3D, CSC-3900G-1



NOTE: WELL DEPTHS RANGE FROM 13 TO 23 FEET.
SCREEN INTERVALS 10 FEET IN LENGTH.

FIGURE 3.2-2
TYPICAL CONSTRUCTION DETAIL-MONITOR WELLS

SOURCE: ESE, 1988

CHARACTERIZATION STUDY - BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

Table 3.2-1. Construction Detail of Ground Water Monitor Wells

Well No.	Installation Date	Well Diameter/ Material	Total Depth (feet BLS)	Screened Depth (feet BLS)	Well Head Completion
CSC-3900-1	7/28/86	2-inch/PVC	23	13-23	Protective Casing/Locking Cap
CSC-3900-2	7/28/86	2-inch/PVC	23	13-23	Protective Casing/Locking Cap
CSC-3900-3D	7/29/86	2-inch/PVC	23	13-23	Protective Casing/Locking Cap
CSC-3900-3S	7/29/86	2-inch/PVC	14	4-14	Protective Casing/Locking Cap
CSC-3900G-1	7/29/86	2-inch/PVC	13	3-13	Protective Casing/Locking Cap
CSC-3900H-1	7/30/86	2-inch/PVC	13	3-13	Protective Casing/Locking Cap
CSC-39J-1	7/30/86	2-inch/PVC	18	8-18	Protective Casing/Locking Cap

Source: ESE, 1986

Table 3.2-2. Elevation Survey Data

Well Identification	Land Surface (feet Above MLW*)	Elevation At Top of Metal Pipe (feet Above MLW)
CSC-3900-1	12.0	14.09
CSC-3900-2	10.2	12.32
CSC-3900-3D	12.4	14.43
CSC-3900-3S	12.6	14.27
CSC-3900G-1	11.0	13.04
CSC-3900H-1	11.8	13.36
CSC-39J-1	9.9	12.21

* MLW = Mean Low Water

Source: NAVBASE Surveyor-Cleetwood Droze, 1986 and CSC-3900H-1 were purged a minimum of three casing volumes of ground water. Because of extremely slow recovery times, monitor wells CSC-3900-3S and CSC-39-J1 were purged of one and one-half, and two casing volumes, respectively. During purging, field measurements of temperature, pH and conductivity were taken. Section 4.3 includes the final results of the field measurements taken on August 11, 1986, prior to aquisition of the ground water samples. The samples were collected with dedicated PVC bailers and transferred to laboratory prepared containers. The samples were packed on ice and shipped to the ESE laboratory for analysis. Sample chain-of-custody forms were included in each shipment. Copies of the sample chain-of-custody forms are included in Appendix D.

On May 18-19, 1987, the seven (7) ground water monitor wells were re-sampled. The purpose of the resampling was to further characterize the hydrocarbon contamination within the surficial aquifer beneath the BTF. Because drought conditions existed during the initial sampling program, ESE recommended that ground water quality also be determined under normal water table conditions by resampling at a later date.

Prior to sampling on May 18 and 19, 1987, the depth to ground water was measured at each monitor well. After water level data were obtained, each monitor well was inspected for the presence of free floating hydro-carbons. A clear acrylic bottom entry bailer was used to withdraw the upper portion of the water column from each monitor well (a bottom entry bailer allows collection of a column of ground water in a relatively undisturbed manner). The bailer was slowly lowered into the water column within the monitor well. As the bailer was submerged the water entered the bailer by displacing an inert teflon® ball which serves as a check valve. As the bailer was retrieved, gravity and the weight of the column forced the ball to set and seal the entry port. Only monitor wells CSC-3900-3D and CSC-39003S contained evidence of free floating hydro-carbons. Monitor well CSC-39J-1 demonstrated a strong odor and a dark opaque appearance, possibly the result of natural biodegradation processes. Each monitor well was purged by hand bailing a minimum of five casing volumes of ground water before sampling. The original, dedicated, PVC bailers were discarded, and new, dedicated PVC bailers were utilized. The ground water collected from each monitor well was analyzed at the time of sampling, in the field, for pH, temperature and specific conductance.

3.3 SURFACE WATER AND SEDIMENT SAMPLING

One surface water and one sediment sample were collected from each of the locations shown on Figure 3.3-1. Sediment samples were collected at approximately the same locations as the surface water samples. At each location, the surface water samples were collected with pre-labeled containers by submerging and filling at mid-depth. Sediments were collected by the grab sampling method using a disposable polyethylene scoop. Temperature, pH and conductivity measurements for surface water samples at each location were recorded following field calibration. These field measurements are presented in Section 5.1

3.4 CHEMICAL ANALYSIS

All soil, ground water, surface water and sediment samples were analyzed utilizing the following methods:

- <u>pH, Temperature, Specific Conductance</u>--These parameters were analyzed for all ground water and surface water samples at the time of collection. A Hydrolab 4000® field instrument was used following field calibration.

- <u>Benzene, Toluene, Xylene</u>--This is a purge and trap method (EPA Method 602) applicable to the determination of benzene, toluene, and xylene (BTX) concentractions.

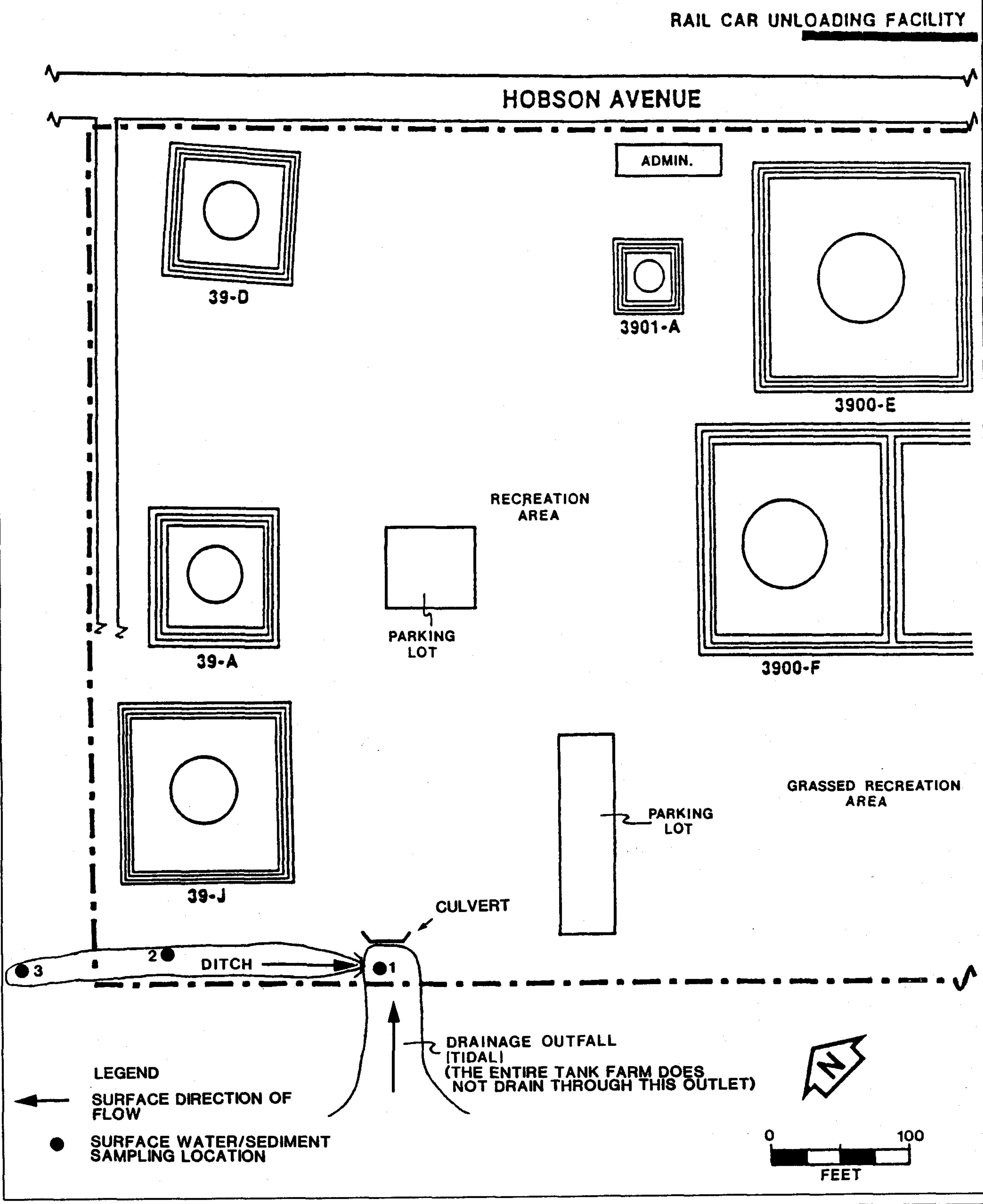


Figure 3.3-1
SURFACE WATER/SEDIMENT SAMPLING LOCATIONS

CHARACTERIZATION STUDY - BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

- Total Recoverable Petroleum Hydrocarbons (TRPH)--The oil and grease analysis by EPA Method 413.2 does not differentiate between extractables of biological origin and the mineral oils and greases of POL origin; therefore, the EPA Infrared Spectrophotometric Method (EPA Method 418.1) for TRPH concentrations was utilized.

In addition to these analyses, the ground water samples collected on May 18 and 19, 1987, included the analysis of PAHs by EPA Method 610, which is summarized as follows:

- Polynuclear Aromatic Hydrocarbons (PAHs)--PAHs were analyzed by EPA Method 610 which covers the determination of 16 individual PAHs (EPA, 1984). The ground water samples were extracted with methylene chloride and the extract was analyzed using high performance liquid chromatography (HPLC) with an ultraviolet (uv) detector.

Results of chemical analysis are provided in Section 5.0.

4.0 SITE HYDROGEOLOGY

4.1 LITHOLOGY

A cross section depicting the shallow lithology beneath the NSC Base Tank Farm is presented on Figure 4.1-1. Soil boring logs detailed from the well cuttings for the monitor wells constructed at the site are presented in Appendix B. The lithologic materials encountered to drilling depths of 25 feet below land surface include fine sand, clay, sandy-clayey silt and marl. HNu/OVA readings were not done on these boreholes.

The site is underlain, from the land surface to depths of two to eight feet, by brown to gray, organic sand and clayey fine sand. **Within the tank areas, the uppermost sands displayed black staining, with some borings exhibiting a black, tar-like substance and a strong petroleum odor** (see soil boring logs, Appendix B).

A non-continuous, clay, local semi-confining zone is present at a depth of 2 to 20 ft BLS underneath the site (Figure 4.1-1). This semi-confining zone is discontinuous in the area of soil boring CSC-3900-3D and CSC-3900-3S and averages approximately nine feet in thickness. This clay layer overlies a layer of silt and clayey silt of moderately low permeability.

The shallow lithology, as depicted in cross-section A-A' presented in Figure 4.1-1, depicts surficial deposits associated with the Talbot Terrace and modified by the Cooper river. Cross-section A-A', represents a perpendicular cross-section of north-south depositional features which parallel and are associated with geomorphological modifications from the nearby Cooper River.

Monitor well TIP readings were taken on May 19, 1987 prior to slug testing. This data is summarized in Section 5.1.

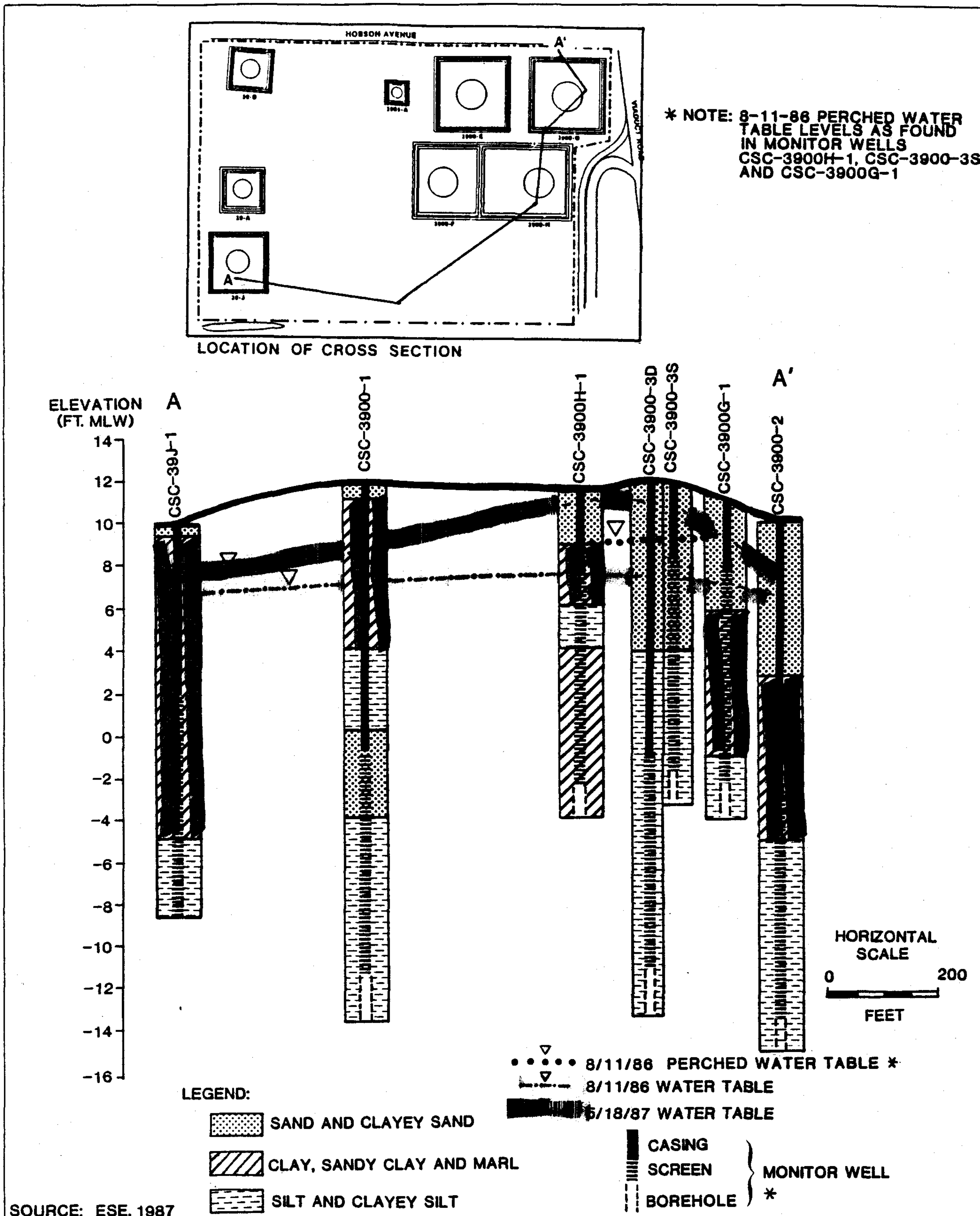


FIGURE 4.1-1

SHALLOW LITHOLOGY

CHARACTERIZATION STUDY - BASE TANK FARM

NAVBASE, CHARLESTON, S.C.

4.2 GROUND WATER ELEVATIONS AND FLOW DIRECTION

Drought conditions existed during the initial field investigation and for several months during the summer of 1986. Water levels in the surfical aquifer were several feet below normal during this time. Perched water table conditions were observed in shallow monitor wells CSC-3900-3S, CSC-3900G-1 and CSC-3900H-1. During the dry season, as the water table receded due to lack of recharge from precipitation, local perching apparently occured in the vicinity of monitor wells SCS-3900-3D and CSC-3900-3S. This is due to local lenses of loamy sand upon which the ground water from the shallow aquifer may perch within the upper surficial sand lithologic unit.

Ground water level measurements were taken from each of the monitor wells prior to purging and sampling on August 11, 1986. Surveyed measuring point (MP) elevations for each monitor well were used to determine the water table elevations in reference to mean low water (MLW). Water level data are presented in Table 4.2-1. Ground water elevations determined for the monitor wells were used to prepare water table contour maps. Water table contours for the perched condition are illustrated on Figure 4.2-1, and for water table conditions on Figure 4.2-2 (also see Figure 4.1-1).

The ground water gradient on August 11, 1986 was to the southwest within the perched water table. Ground water flow patterns within the depressed water table (see Figure 4.2-2) were radially outward in a northerly and easterly direction on August 11, 1986. During the primary field investigation performed in July, 1986, a perched water table occurred due to the combined effect of a lowered water table condition in response to the drought and recent precipitation infiltration which was held up on low permeability, shallow soils beneath the BTF. **Ground water elevations** within the water table aquifer may potentially be **affected by tidal changes** and the **close proximity of the Cooper River**, which is tidally-influenced in the area of NAVBASE CHARLESTON. The field investigation

Table 4.2-1. Water Level Data for August 11, 1986 and May 18, 1987

Monitor Well No.	Land Surface Elevation (feet above MLW)	Measuring Point Elevation (feet above MLW)	08/11/86 Distance To Water Table (feet)	05/18/87 Distance To Water Table (feet)	08/11/86 Water Table Elevation (feet above MLW)	05/18/87 Water Table Elevation (feet above MLW)	Elevation of the top of the screened Interval (feet above MLW)
CSC-3900-1	12.0	14.09	6.78	5.21	7.31	8.88	-1.0
CSC-3900-2	10.2	12.32	5.61	4.57	6.71	7.75	-2.8
CSC-3900-3D	12.4	14.43	6.61	3.42	7.82	11.01	-0.6
CSC-3900-3S	12.6	14.27	4.87	3.15	9.40	11.12	8.6
CSC-3900G-1	11.0	13.04	3.44	3.35	9.60	9.69	8.0
CSC-3900H-1	11.8	13.37	4.09	2.11	9.28	11.26	7.8
CSC-39J-1	9.9	12.21	5.41	4.68	6.80	7.53	1.9

Source: NAVBASE Surveyor-Cleetwood Droze, 1986
ESE, 1986
ESE, 1987

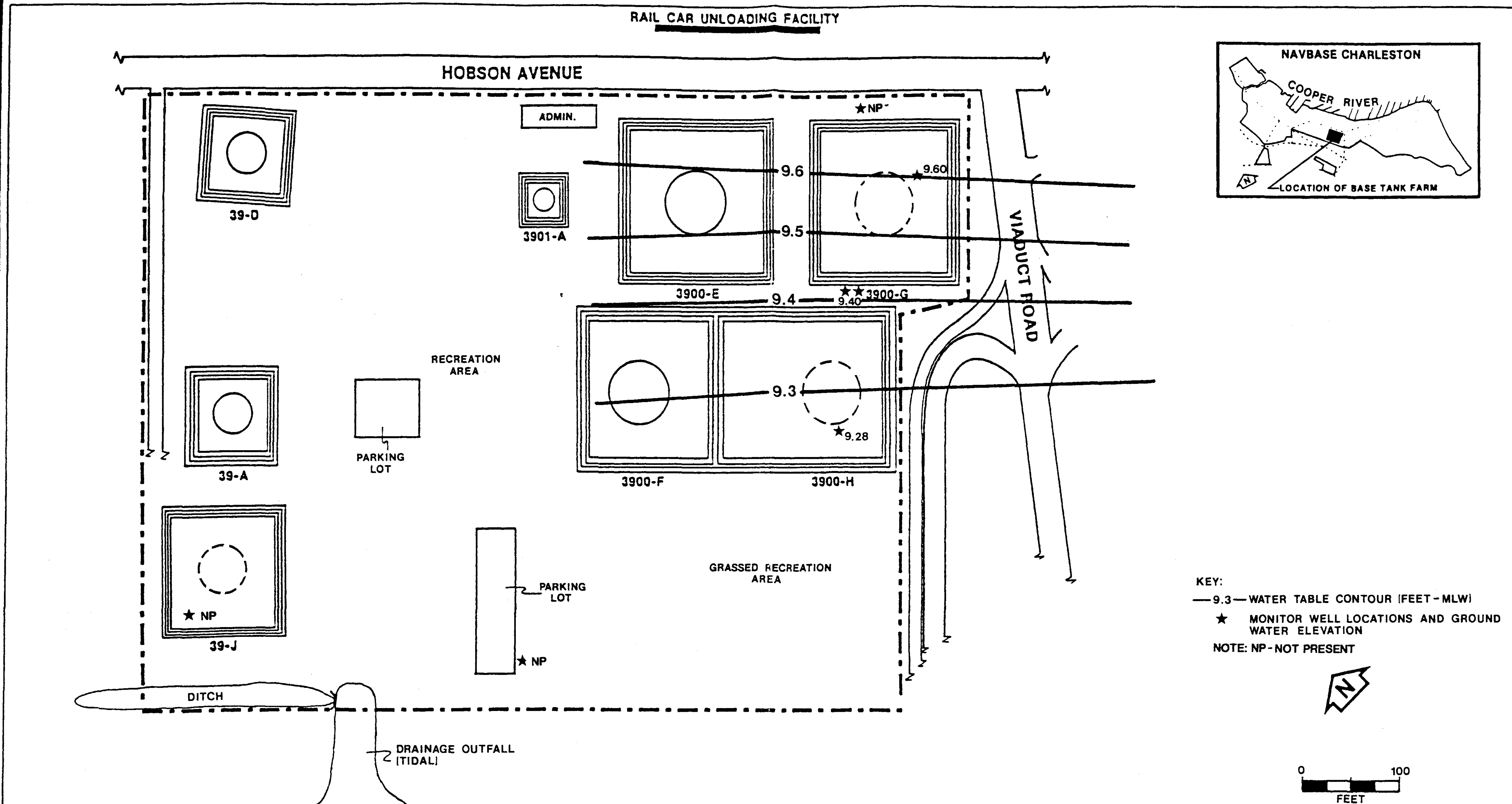


Figure 4.2-1
PERCHED WATER TABLE CONTOUR MAP
AUGUST 11, 1986

CHARACTERIZATION STUDY -
BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

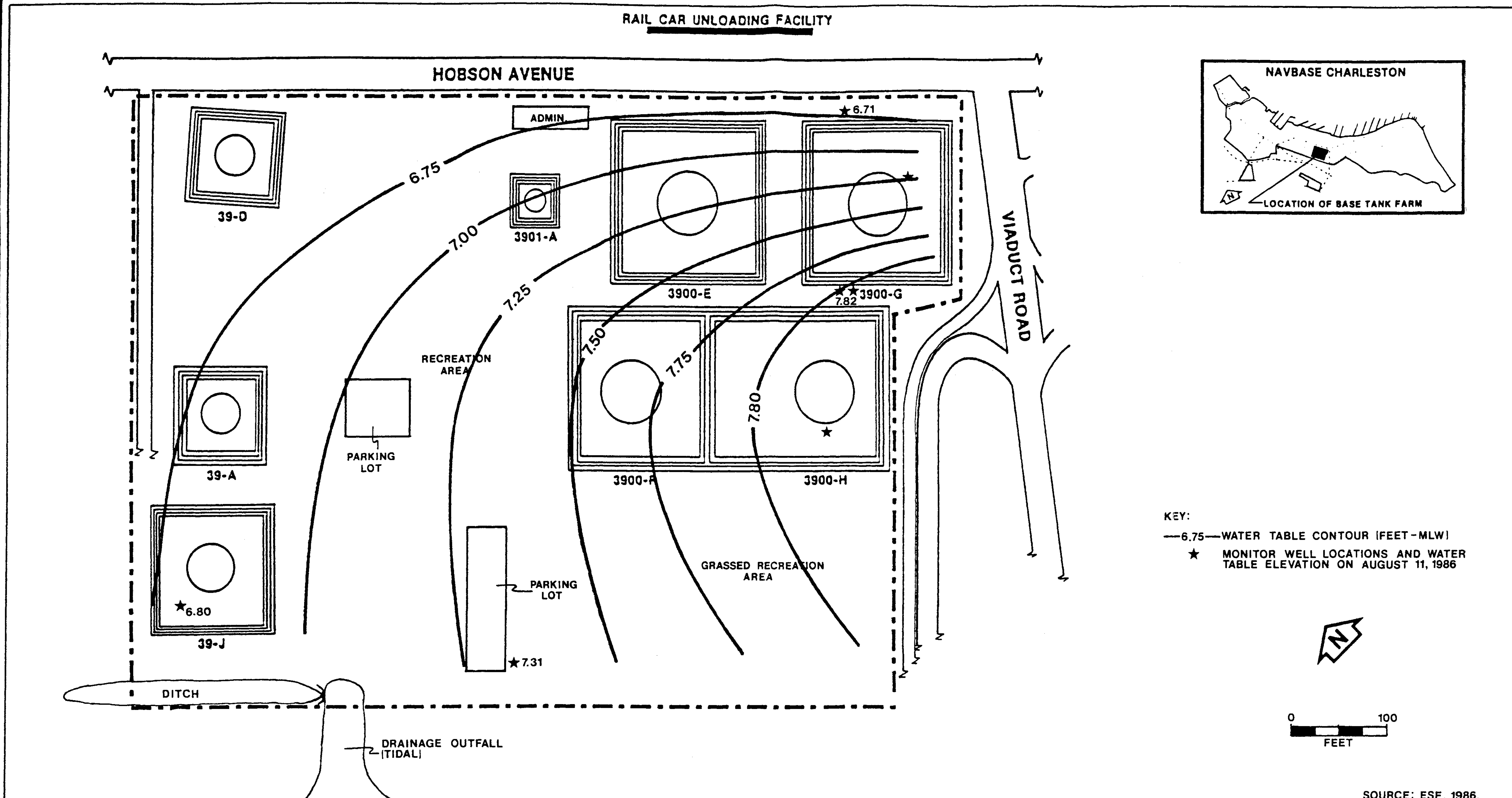


Figure 4.2-2
WATER TABLE CONTOUR MAP

CHARACTERIZATION STUDY -
BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

did not quantify this possible tidal effect. Although there may be a minor tidal impact present at the site, this effect should not significantly alter the overall groundwater flow direction at the site, which is toward the Cooper River.

A water table contour map shown on Figure 4.2-3 was prepared from data obtained during the resampling investigation on May 18, 1987 and presented on Table 4.2-1. The water levels measured at monitor wells CSC-3900-3D and CSC-3900-3S did not vary more than .11 foot, indicating that the water table had normalized since being affected by the drought conditions which occurred during the summer of 1986 (see Figure. 4.1-1). The water table contours on Figure 4.2-3 follow the same general pattern displayed by the water table contours depicted in the Characterization Study. The ground water movement is radially outward from the BTF towards Cooper River to the north and northeast, and towards the drainage basin to the west and northwest. The ground water gradient is steepest (0.02 ft/ft) towards Cooper River to the northeast and the least (.0005 ft/ft) to the northwest.

4.3 AQUIFER TESTING

Single well aquifer testing was performed following monitor well sampling on May 18-19, 1987 on monitor wells CSC-3900-1, CSC-3900-2 and CSC-3900G-1. The single well aquifer test is appropriate for determining hydraulic conductivity within fully or partially penetrating well in unconfined aquifers. The principle involves instantaneous displacement of a volume of water in the well and measuring the water level within the well over time as the well recovers. The hydraulic conductivity of the aquifer can be determined by analyzing the resultant plot of water level recovery versus time.

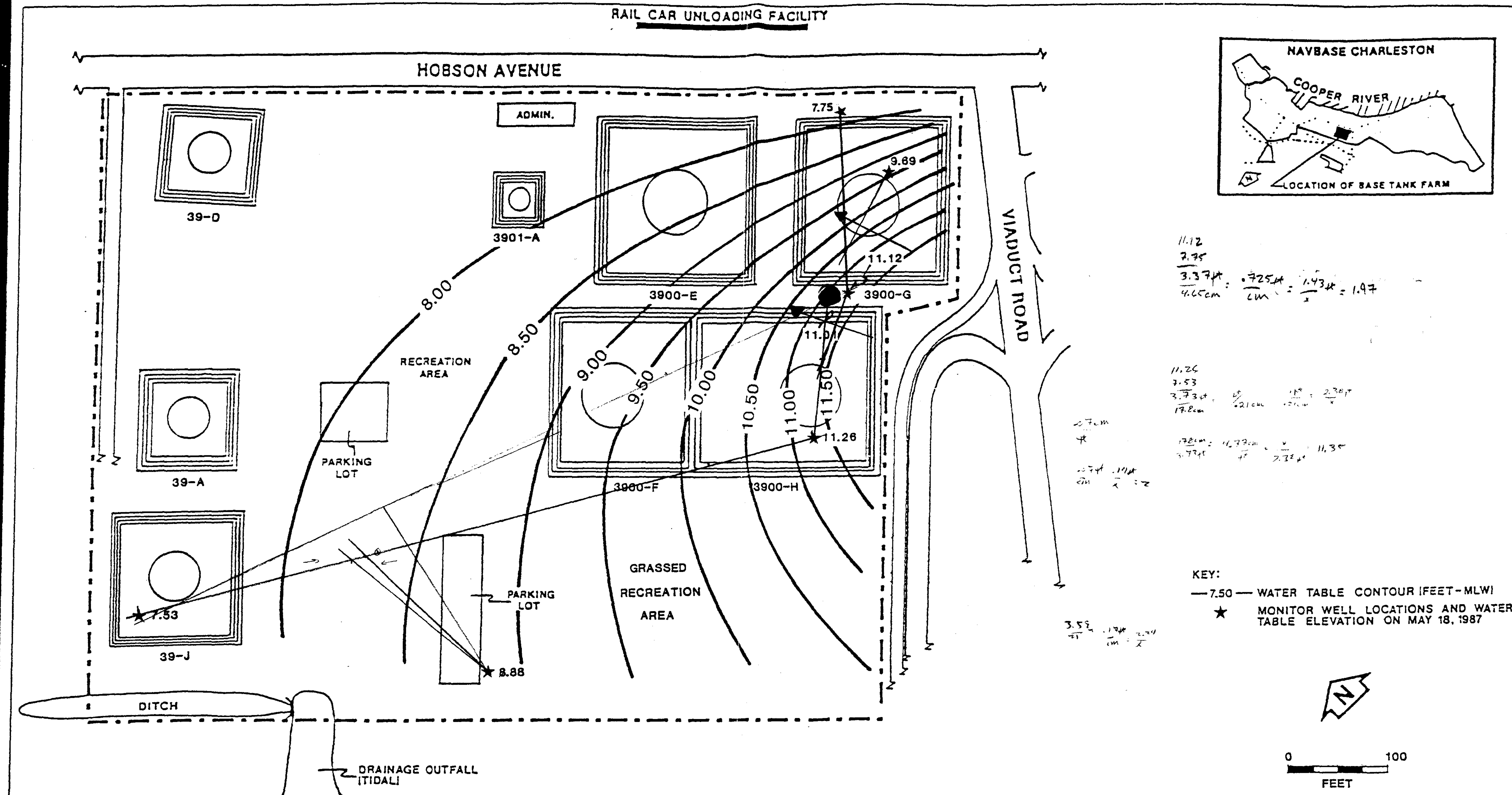


Figure 4.2-3
WATER TABLE CONTOUR MAP
NAVBASE CHARLESTON
MAY 18, 1987

CHARACTERIZATION STUDY -
BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

Table 4.3-1 Summary of Slug Test Results for NSC Base Tank Farm

Well No.	Slug In Test Results (cm/sec)	Slug Out Test Results (cm/sec)	Average Hydraulic Conductivity (cm/sec)
CSC-3900-1	4.23×10^{-4}	1.57×10^{-4}	2.90×10^{-4}
CSC-3900-2	1.21×10^{-4}	2.12×10^{-5}	7.12×10^{-5}
CSC-3900G-1	1.41×10^{-4}	2.47×10^{-5}	8.29×10^{-5}

Source: ESE, 1988

By substituting a maximum measured hydraulic gradient of 0.02 cm/cm, an average hydraulic conductivity of 2.90×10^{-4} cm/sec measured from the slug in and slug out tests at monitor well CSC-3900-1, and a porosity for sand of 0.3, an average ground water flow rate of 1.93×10^{-5} cm/sec or 20.0 ft/yr was determined for the sand.

By substituting a maximum measured hydraulic gradient of 0.02 cm/cm, an average hydraulic conductivity of 7.12×10^{-5} cm/sec measured from the slug in and slug out tests at monitor well CSC-3900-2, and a porosity for silt of 0.4, an average ground water flow rate of 3.56×10^{-6} cm/sec or 3.7 ft/yr was determined for silt.

5.0 CONTAMINATION ASSESSMENT

5.1 CONTAMINANT DISTRIBUTION

Field testing and laboratory analysis indicate that petroleum hydrocarbon contamination of the soils and/or ground water has occurred in the vicinity of tanks 3900-G, 3900-H and 39-J. Tables 5.1-1 through 5.1-4 provide analytical results for TRPH and BTX concentrations in soil, ground water, surface water and sediment samples collected during the July and August 1986 field investigation. Table 5.1-5 summarizes the visual and olfactory observations during shallow soil boring construction.

Compared to the TRPH levels observed in the ground water, the soil and sediment samples displayed high levels of TRPH contamination. For example, TRPH concentrations in soils ranged from 39.5 to 9,010 mg/kg (parts per million or ppm) while ground water samples contained 0.341 to 130 mg/l (ppm). The differences in ranges of concentrations between the soils and ground water reflect the high hydrophobicity of these petroleum-related compounds (i.e., they exhibit a strong tendency to adsorb onto solid materials such as soils in which they come into contact.

TRPH's were detected in all sediment and soil samples with the exception of SB-8 and SB-9. As shown in Table 5.1-1, TRPH concentrations in soil samples ranged from 39.5 mg/kg in soil boring SB-11 to 9,010mg/kg in soil boring SB-6. Sediment samples SE-1, SE-2 and SE-3 contained TRPH concentrations of 135 mg/kg, 268 mg/kg and 43.9 mg/kg, respectively (Table 5.1-4). BTX's were not detected in any of the soil or sediment samples indicating that gasoline products were not released in this area. Gasoline contains high levels of BTX compounds. Figure 5.1-1 shows TRPH concentrations for each soil and sediment sampling location, and areas of visual and olfactory evidence of contamination observed during the field investigation. The shallow soil boring logs are presented in Appendix A.

Table 5.1-1 Analytical Results for Soil Samples (Page 1 of 2)

Parameter	Units	Method	Detection Limits *	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6	SB-7
Moisture	% Wet Wt.	70320	-	18.9	60.6	7.0	13.1	15.3	16.6	1.2
TRPH	mg/kg (ppm)	98233	33.7 - 35.3	7280	146	1370	979	510	9010	249
Benzene	µg/kg (ppb)	34237	84.1 - 200	<102	<200	<89.4	<95.9	<98.4	<99.4	<84.1
Chlorobenzene	µg/kg (ppb)	34304	84.1 - 200	<102	<200	<89.4	<95.9	<98.4	<99.4	<84.1
Dichlorobenzene, Total	µg/kg (ppb)	98578	84.1 - 200	<102	<200	<89.4	<95.9	<98.4	<99.4	<84.1
Ethylebenzene	µg/kg (ppb)	34374	84.1 - 200	<102	<200	<89.4	<95.9	<98.4	<99.4	<84.1
Toluene	µg/kg (ppb)	34483	84.1 - 200	<102	<200	<89.4	<95.9	<98.4	<99.4	<84.1
Xylenes, Total	µg/kg (ppb)	45510	84.1 - 200	<102	<200	<89.4	<95.9	<98.4	<99.4	<84.1

Source: ESE 1986

Note: mg/kg = Milligram per kilogram
µg/kg = Micrograms per kilogram

* Detection limits vary according to soil moisture content

Table 5.1-1 Analytical Results for Soil Samples (Page 1 of 2)

Parameter	Units	Method	Detection Limits *	SB-8	SB-9	SB-10	SB-11	SB-12	SB-13	SB-14	SB-15
Moisture	% Wet Wt.	70320	-	22.2	18.5	24.0	28.7	25.0	22.7	15.7	28.0
TRPH	mg/kg (ppm)	98233	33.7 - 35.3	<35.3	<33.7	1050	39.5	55.9	2470	238	121
Benzene	µg/kg (ppb)	34237	84.1 - 200	<106	<102	<109	<117	<111	<107	<98.4	<115
Chlorobenzene	µg/kg (ppb)	34304	84.1 - 200	<106	<102	<109	<117	<111	<107	<98.4	<115
Dichlorobenzene, Total	µg/kg (ppb)	98578	84.1 - 200	<106	<102	<109	<117	<111	<107	<98.4	<115
Ethylebenzene	µg/kg (ppb)	34374	84.1 - 200	<106	<102	<109	<117	<111	<107	<98.4	<115
Toluene	µg/kg (ppb)	34483	84.1 - 200	<106	<102	<109	<117	<111	<107	<98.4	<115
Xylenes, Total	µg/kg (ppb)	45510	84.1 - 200	<106	<102	<109	<117	<111	<107	<98.4	<115

Source: ESE 1986

Note: mg/kg = Milligram per kilogram
µg/kg = Micrograms per kilogram

* Detection limits vary according to soil moisture content

Table 5.1-2 Analytical Results for Ground Water Samples Sampled on August 11, 1986

Parameter	Units	Method	Detection Limits	CSC-3900-1	CSC-3900-2	CSC-3900-3D	CSC-3900-3S	CSC-3900G-1	CSC-3900H-1	CSC-39J-1
pH	S.U.	Field	-	7.1	7.9	7.6	7.8	8.0	7.7	7.7
Temperature	°C	Field	-	23.6	23.0	22.0	26.3	26.5	27.2	21.1
Conductivity	µmhos/cm	Field	-	12,600	38,500	24,300	22,200	5,320	3,800	31,200
TRPH	µg/l	45501	183 - 194	<190	<194	<190	**130,000**	**2,850**	**341**	<183
Benzene	µg/l	3403D	1.00	<1.00	<1.00	<1.00	**1.23**	<1.00	<1.00	<1.00
Chlorobenzene	µg/l	34301	1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Dichlorobenzene, Total	µg/l	81524	1.00 - 3.00	<3.00	<3.00	<3.00	<3.00	<3.00	<1.00	<1.00
Ethylebenzene	µg/l	34371	1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Toluene	µg/l	34010	3.00	<3.00	<3.00	<3.00	<3.00	<3.00	<3.00	<3.00
Xylenes, Total	µg/l	81551	1.00 - 3.00	<3.00	<3.00	<3.00	<3.00	<3.00	<1.00	<1.00

Source: ESE 1986

Note: S.U. = Standard Units
µmhos/cm = Micromhos per centimeter
µg/l = Micrograms per liter

Table 5.1-3 Analytical Results for Surface Water Samples

Parameter	Units	Method	Detection Limits	SW-1	SW-2	SW-3
pH	S.U.	Field	-	7.1	7.4	6.5
Temperature	°C	Field	-	29.4	28.5	27.7
Conductivity	µmhos/cm	Field	-	26,000	27,900	26,700
TRPH	µg/l	45501	184 - 190	<184	<190	<188
Benzene	µg/l	34030	1.0	<1.00	<1.00	<1.00
Chlorobenzene	µg/l	34301	1.0	<1.00	<1.00	<1.00
Dichlorobenzene, Total	µg/l	81524	1.0	<1.00	<1.00	<1.00
Ethylebenzene	µg/l	34371	1.0	<1.00	<1.00	<1.00
Toluene	µg/l	34010	3.0	<3.00	<3.00	<3.00
Xylenes, Total	µg/l	81551	1.0	<1.00	<1.00	<1.00

Source: ESE 1986

Note: S.U. = Standard Units

µmhos/cm = Micromhos per centimeter

µg/l = micrograms per liter

Table 5.1-4 Analytical Results for Sediment Samples

Parameter	Units	Method	Detection Limits	SE-1	SE-2	SE-3
Moisture	% Wet Wt.	70320	-	36.8	33.7	17.8
TRPH	mg/kg (ppm)	98233	35	[redacted]	[redacted]	[redacted]
Benzene	µg/kg (ppb)	34237	161 - 211	<211	<200	<161
Chlorobenzene	µg/kg (ppb)	34304	161 - 211	<211	<200	<161
Dichlorobenzene, Total	µg/kg (ppb)	98578	161 - 211	<211	<200	<161
Ethylebenzene	µg/kg (ppb)	34374	161 - 211	<211	<200	<161
Toluene	µg/kg (ppb)	34483	161 - 211	<211	<200	<161
Xylenes, Total	µg/kg (ppb)	45510	161 - 211	<211	<200	<161

Source: ESE 1986

Note: mg/kg = Milligram per kilogram
µg/kg = Micrograms per kilogram

Table 5.1-5 Visual and Olfactory Observations During Shallow Soil Boring Construction. (Page 1 of 3)

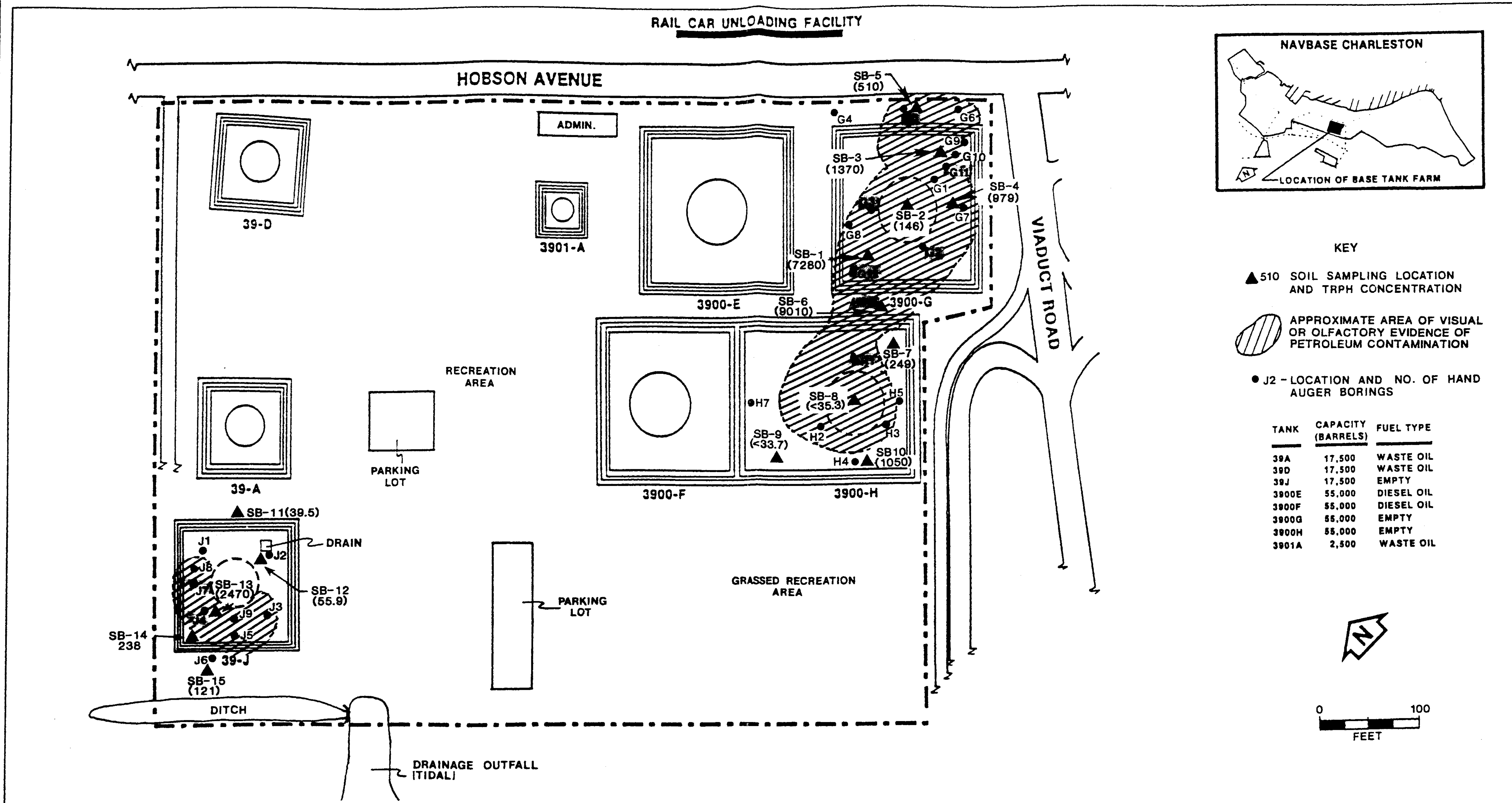
Boring No.	Depth (feet BLS)	Visual	Olfactory Petroleum Odor
G-1	0 - 1.5	None	Minor
	1.5 - 3.0	None	Moderate
G-2	0 - 1.0	None	Minor
	1.0 - 1.5	None	Moderate
	1.5 - 2.5	None	[redacted]
G-3	0 - 1.5	None	Minor
	1.5 - 2.5	None	[redacted]
G-4	0 - 2.0	None	None
	2.0 - 3.0	None	None
	3.0 - 3.5	None	None
G-5	0 - 1.0	None	Minor
	1.0 - 2.5	Staining	[redacted]
G-6	0 - 0.5	None	None
	0.5 - 2.5	[redacted]	Minor
G-7	0 - 1.0	None	Minor
	1.0 - 1.5	None	Minor
	1.5 - 3.0	None	Minor
G-8	0 - 1.5	None	None
	1.5 - 2.8	None	None
	2.8 - 3.2	Slight	Slight
G-9	0 - 1.5	None	None
	1.5 - 2.5	None	None
	2.5 - 3.0	None	None
G-10	0 - 3.0	None	Minor
G-11	0 - 1.5	None	Minor
	1.5 - 3.0	None	[redacted]
	3.0 - 3.5	None	Minor
G-12	0 - 1.0	None	Minor
	1.0 - 3.0	None	[redacted]

Table 5.1-5 Visual and Olfactory Observations During Shallow Soil Boring Construction. (Page 2 of 3)

Boring No.	Depth (feet BLS)	Visual	Olfactory Petroleum Odor
H-1	0 - 1.5	Slight	Minor
	1.5 - 3.0	Oil/tar-like	Strong
H-2	0 - 1.0	Stained	Minor
	1.0 - 2.5	Oil & Tar	Moderate
	2.5 - 3.0	None	None
H-3	0 - 1.5	None	Moderate
	1.5 - 2.0	Stained	Moderate
	2.0 - 2.5	None	None
H-4	0 - 1.5	None	None
	1.5 - 3.0	None	None
H-5	0 - 1.5	None	None
	1.5 - 2.0	None	None
	2.0 - 3.0	None	None
H-6	0 - 1.0	None	Minor
	1.0 - 2.5	Slight	Strong
	2.5 - 3.0	None	Minor
H-7	0 - 2.5	None	None
	2.5 - 3.0	None	None
J-1	0 - 1.0	None	None
	1.0 - 2.0	None	None
	2.0 - 3.0	None	None
J-2	0 - 1.0	None	None
	1.0 - 2.0	None	None
	2.0 - 3.0	None	None
J-3	0 - 1.0	None	None
	1.0 - 2.0	None	None
	2.0 - 3.0	None	Slight
J-4	0 - 1.0	None	Minor
	1.0 - 2.0	None	Moderate
	2.0 - 3.0	None	Strong

Table 5.1-5 Visual and Olfactory Observations During Shallow Soil Boring Construction. (Page 3 of 3)

Boring No.	Depth (feet BLS)	Visual	Olfactory Petroleum Odor
J-5	0 - 1.0	None	Minor
	1.0 - 2.0	None	Minor
	2.0 - 3.0	None	Moderate
J-6	0 - 1.0	None	None
	1.0 - 2.0	None	None
	2.0 - 3.0	None	None
J-7	0 - 1.0	None	[illegible]
	1.0 - 2.0	None	Strong
	2.0 - 3.0	None	Moderate
	3.0 - 3.5	None	Slight
J-8	0 - 1.0	None	Slight
	1.0 - 2.0	None	Slight
	2.0 - 3.0	None	Slight
J-9	0 - 1.0	None	Slight
	1.0 - 2.0	None	Slight
	2.0 - 3.0	None	None



TANK	CAPACITY (BARRELS)	FUEL TYPE
39A	17,500	WASTE OIL
39D	17,500	WASTE OIL
39J	17,500	EMPTY
3900E	55,000	DIESEL OIL
3900F	55,000	DIESEL OIL
3900G	55,000	EMPTY
3900H	55,000	EMPTY
3901A	2,500	WASTE OIL

Figure 5.1-1

TRPH CONCENTRATIONS AND APPROXIMATE AREAS OF VISUAL/OLFACTORY EVIDENCE OF PETROLEUM CONTAMINATION

CHARACTERIZATION STUDY - BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

During ground water sampling conducted on August 11, 1986, monitor well CSC-3900-3S contained one-half inch of a dark, viscous petroleum product floating on the water table. Monitor well CSC-3900G-1 displayed a very faint petroleum odor but contained no free product. The remaining wells did not display any diffinitive evidence of hydrocarbon contamination. The relationship of the top of the monitor well screens to the top of the top of the water table is shown in Figure 4.1-1. The monitor wells were installed during a drought, and three screened monitor wells were for shallow intervals. Four monitor wells were screened for deep intervals. Since the wells were installed during a drought, the water table elevation could not be readily determined at the time of installation and the screened interval was set too deep for normal water table conditions. **Free floating product cannot be determined accurately in the ground water, above the screened interval.** Nevertheless, ground water samples were found to contain TRPH concentrations of **341** [redacted] **µg/l in shallow monitor wells** CSC-3900H-1, [redacted] respectively. Benzene was detected in monitor well CSC-3900-3D at a concentration of 1.23 µg/l. TRPH and BTX concentrations were below detection limits at the remaining deeper monitor wells CSC-3900-1, CSC-3900-2, CSC-3900-3D and CSC-39J-1. Figure 5.1-2 shows TRPH concentrations in the ground water in the vicinity of monitor wells CSC-3900-3S, CSC-3900G-1, and CSC-3900H-1 on August 11, 1986. The surface water samples did not contain detectable concentrations of TRPH or BTX compounds.

Monitor well organic vapor readings were taken utilizing a Total Ionizables Present (TIP) organic vapor detector prior to the aquifer slug tests on May 19, 1987. This data is summarized in Table 5.1-6. The TIP data shows the same trend as the PAH and TRPH data with highest concentrations found in monitor wells CSC-3900-3S and CSC-3900-3D. The TIP readings were taken in the monitor well headspace utilizing a teflon® tube and silicon stopper.

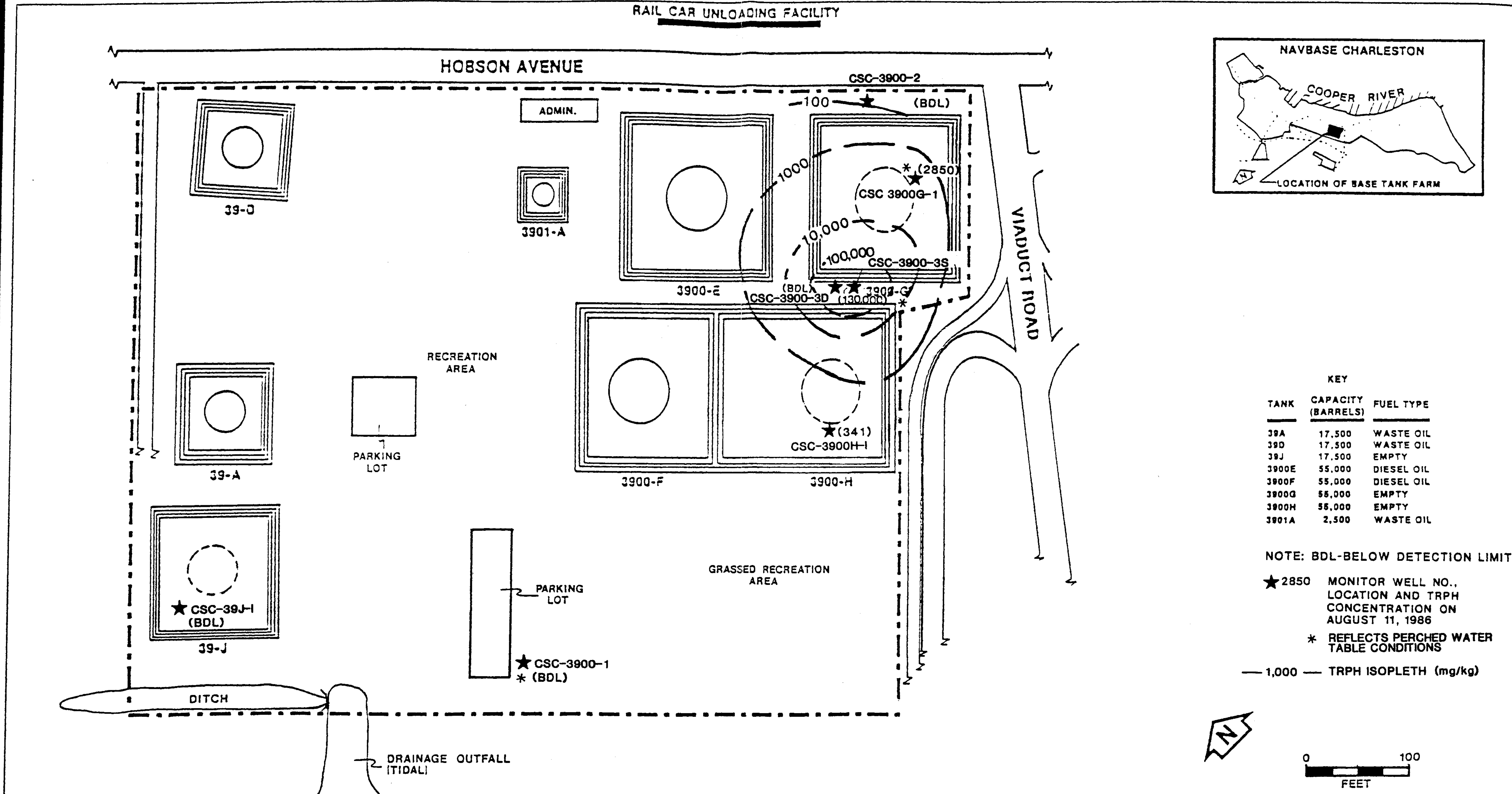


Figure 5.1-2
TRPH CONCENTRATIONS IN GROUND WATER SAMPLES COLLECTED ON AUGUST 11, 1986

CHARACTERIZATION STUDY - BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

Table 5.1-6 Monitor Well TIP Readings Taken Prior to Slug Testing, May 19, 1987

Well No.	TIP* (ppm)	Time
CSC-3900-1	0.7	0715
CSC-3900-2	2.6	0819
CSC-3900-3D	16.9	0844
CSC-3900-3S	21.0	0849
CSC-3900G-1	3.4	0825
CSC-3900H-1	4.1	0905
CSC-39J-1	1.7	0731

* TIP - head space - silicon stopper - teflon tube

Source: ESE, 1987

On May 18 and 19, 1987, the seven (7) monitor wells were resampled. As indicated on Table 5.1-7, the shallow ground water at the NSCBTF ranged from moderately acidic at monitor well CSC-39J-1 (pH = 5.30) to slightly alkaline at monitor well CSC-3900G-1 (pH = 7.60). Specific conductance values ranged from 3,050 micromhos per centimeter (µmhos/cm) to 33,500 µmhos/cm with an average specific conductance value of 11,626 µmhos/cm. This indicates dissolved solids levels of 2,000 to 20,000 milligrams per liter (mg/l), with an average of 11,560 mg/l.

The analytical results did not detect the presence of any BTX compounds normally indicative of gasoline contamination. Since gasoline contains high levels of BTX compounds and no BTX compounds were detected, no gasoline apparently was released at the site. TRPHs were detected in monitor wells CSC-3900-3D and CSC-3900-3S at concentrations of 6.68 mg/l and 9.41 mg/l, respectively. PAHs were detected in each monitor well ranging from a minimum of two compounds at monitor well CSC-3900-1 to a maximum of twelve compounds at monitor wells CSC-3900-3D and CSC-3900-3S. To evaluate the significance of the PAH analysis, total PAHs were determined for each monitor well by summing arithmetically the concentrations of the PAH compounds present above analytical detection limits. Total PAHs ranged from 0.6 micrograms per liter (µg/l) at monitor well CSC-3900-1 to 1,861 µg/l at monitor well CSC-3900-3S. PAH compounds are constituents of waste oil and diesel fuel, both of which had been stored in BTF.

The analytical results for TRPHs for ground water samples collected on August 11, 1986 during a period of a low water table and May 18-19, 1987 during a period of a high water table show lower TRPHs for monitor wells CSC-3900-3S, CSC-3900G-1 and CSC-3900H-1 for the May 18-19, 1987 samples. Increased dilution factors for the higher water table along with the fact that the top of the water table was well above the well screens in these wells may account for the observed differences in TRPH concentrations between the two sampling periods. TRPHs and PAHs were observed for

Table 5.1-7 Analytical Results for Ground Water Samples Sampled on May 18 and 19, 1987

Parameter	Units	Detection Limits	Monitor Well No.						
			CSC-3900-1	CSC-3900-2	CSC-3900-3D	CSC-3900-3S	CSC-3900G-1	CSC-3900H-1	CSC-39J-1
Water Temp.	°C	-	23.2	21.8	22.6	22.5	21.6	23.1	22.1
pH, field	Std Uts	-	5.30	7.10	6.90	7.00	7.60	7.10	6.30
Sp. Cond. field @25°C	umhos/cm	-	9750	33500	24600	21000	5880	3050	25600
Petroleum Hydrocarbons	μg/l	217 - 260	<233	<222	[redacted]	[redacted]	<222	<217	<260
PURGEABLE AROMATICS									
Benzene	ug/l	10	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Toluene	ug/l	20	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Xylenes, Total	ug/l	3	<3.00	<3.00	<3.00	<3.00	<3.00	<3.00	<3.00
POLYNUCLEAR AROMATIC HYDROCARBONS									
Acenaphthene	ug/l	0.363	<0.363	<0.363	4.10	82.1	5.86	<0.363	<0.363
Acenaphthylene	ug/l	0.202	<0.202	0.377	<2.02	<10.1	15.2	<0.202	0.252
Anthracene	ug/l	0.023	<0.023	0.105	4.06	53.6	2.15	0.027	<0.023
Benzo(a)anthracene	ug/l	0.017 - 0.168	<0.017	0.035	5.37	16.1	<0.168	<0.017	0.019
Benzo(a)pyrene	ug/l	0.029	<0.029	<0.029	0.644	3.61	0.302	<0.029	0.031
Benzo(b)fluoranthene	ug/l	0.017	<0.017	<0.017	0.846	4.74	0.186	<0.017	<0.017
Benzo(ghi)perylene	ug/l	0.059 - 2.96	<0.059	<0.059	<0.593	<2.96	<0.593	<0.059	<0.059
Benzo(k)fluoranthene	ug/l	0.018 - 0.180	<0.018	<0.018	0.398	2.94	<0.180	<0.018	<0.018
Chrysene	ug/l	0.012	<0.012	<0.012	0.999	7.75	1.86	<0.012	<0.012
Diben(a,h)anthracene	ug/l	0.715 - 3.58	0.425	0.287	<0.715	<3.58	<0.715	0.287	0.383
Fluoranthene	ug/l	0.049	<0.049	0.331	13.0	123	6.01	0.107	0.061
Fluorene	ug/l	0.043	<0.043	3.34	2.71	38.3	6.53	<0.043	1.62
Indeno(1,2,3-cd)pyrene	ug/l	0.044 - 2.20	<0.044	<0.044	<0.440	<2.20	<0.440	<0.044	<0.044
Naphthalene	ug/l	0.156	<0.156	2.64	8.00	49.0	6.42	0.342	1.22
Phenanthrene	ug/l	0.156	0.178	3.06	17.1	1410	24.3	0.782	0.387
Pyrene	ug/l	0.048	<0.048	0.214	12.6	59.9	4.90	0.094	0.050
Total PAHs*	μg/l	-	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

* Total PAHs include arithemic summation of detected compounds only.

Source: ESE, 1987

monitor well CSC-3900-3D for the May 18-19, 1987 samples. CSC-3900-3D was installed in the deeper portion of the surficial aquifer. The observed contaminants in this well indicates vertical migration of petroleum contaminants in the surficial aquifer. **Since the surficial aquifer is continuous beneath the site, varying only in vertical and horizontal conductivity, vertical contamination of the entire thickness of the surficial aquifer is occurring. This contamination will spread vertically until the equilibrium is reached.** The screened intervals in the monitor wells are necessary to obtain representative ground water samples from the upper, middle, and lower portions of the shallow aquifer. The screened intervals have not breached any effective subsurface confining zone. Lenses of loamy or slightly clayey sand in the surficial sand deposits may cause local perching of the water table. However, these local lenses are discontinuous and do not form effective confining zones.

5.2 CONTAMINANT ASSESSMENT

As shown on Figures 5.1-1 and 5.1-2, and discussed in the previous section, petroleum migration has occurred within the soils and shallow ground water of the Base Tank Farm. Petroleum within the soils surrounding tanks 3900-G and 3900-H appears to have spread radially from the tank bases. Petroleum within the soils in the vicinity of tank 39-J has migrated to the western corner of the tank impoundment.

An examination of the boring logs from **monitor wells CSC-3900-[illegible], CSC-3900G-1, CSC-3900-3D, CSC-3900-3S, and CSC-3900H-1** in the **vicinity** of former **tanks 3900-G and 3900-H** indicates subsurface **soil contamination vertically to a depth of approximately 8.0** ft in this area. The approximate areal extent of this contamination, as shown in Figure 5.1-1, is 49,800 square feet, therefore, the approximate volume of the contaminated soil is 398,400 cubic feet or 14,740 cubic yards.

An examination of the boring logs from [illegible] in the vicinity of former tank 39J shows subsurface soil contamination vertically to a depth of 4.0 ft. The approximate areal extent of this contamination, as shown in Figure 5.1-1 is 6,000 square feet. The approximate volume of the contaminated soils in this area is 24,000 cubic feet or 890 cubic yards.

Based on the data for TRPH and PAHs, vertical migration of both free and dissolved petroleum has occurred in the vicinity of tanks 3900-G and 3900-H. Based on this sampling and analyses, the significant PAH contamination is limited areally to the immediate vicinity of tanks 3900-G and 3900-H. Although PAH compounds were detected in the ground water at the other monitor wells, the levels were very low in comparison. These PAH compounds have very low aqueous solubilities and exhibit a strong tendency to adsorb onto solid materials in which they come into contact (i.e., exhibit a high hydrophobicity). The observed difference in total PAH concentrations between the shallow monitor well CSC-3900-3S (1,851 μg/l) and the adjacent, deeper monitor well CSC-3900-3D (70 μg/l) indicates that although vertical migration of PAH compounds is evident, attenuation of these compounds apparently is occurring. Additionally, the differences in total PAH compounds between monitor well CSC-3900-3S (1,851 μg/l) and the hydraulically downgradient monitor wells CSC-3900G-1 (74 μg/l) and CSC-3900-2 (10 μg/l) indicate that similar attenuation is occurring. Apparently, the PAH compounds [illegible] adsorbed by soils (as predicted by their known high partition coefficients) [illegible] the general BTF area or are being diluted by [illegible] inputs of uncontaminated ground water.

Monitor well casing, analytical, and water table elevation data are summarized in Table 5.2-1. As previously described, the monitor wells were installed during a record drought condition. The well screens of the shallow monitor wells were intended to be installed to monitor the extreme upper portion of the water column. Following equilibration, the water table was slightly above the well screen. As shown in Table 5.2-1, the monitor well analytical data shows that the upper portion of the

Table 5.2-1 Monitor Well Summary Table

Monitor Well No.	Date Sampled or Measured	Elevation Top of Well Screen (Ft above MLW)	Water Table Elevation (Ft above MLW)	TRPH (µg/L)	Total PAHs (µg/L)
CSC-3900-1	8/11/86	-1.0	7.31	<190	
	5/18/87	-1.0	8.88	<233	.0.0.,0.6
CSC-3900-2	8/11/86	-2.8	6.71	<194	
	5/18/87	-2.8	7.75	<222	10.4
CSC-3900-3D	8/11/86	-0.6	7.82	<190	
	5/18/87	-0.6	11.01	[redacted]	69.8
CSC-3900-3S	8/11/86	8.6	9.40	[redacted]	
	5/18/87	8.6	11.12	9,410	1851
CSC-3900G-1	8/11/86	8.0	9.60	2,850	
	5/18/87	8.0	9.69	<222	73.7
CSC-3900H-1	8/11/86	7.8	9.28	341	
	5/18/87	7.8	11.26	<217	1.6
CSC-39J-1	8/11/86	1.9	6.80	<183	
	5/18/87	1.9	7.53	<260	4.0

Source: ESE, 1988

ground water column is significantly contaminated by PAH contamination in the vicinity of tanks 3900-G and 3900-H. Low level PAH contamination covers much of the project site in the lower portion of the ground water column of the project. A comparison of the areal extent of the soil contamination to the areal extent of total PAH ground water contamination in the upper and lower portions of the surficial aquifer, is shown in Figure 5.2-1. Although the isopleths of the total PAHs are largely inferred, and the actual shape of the plume may be better defined through the installation of additional monitor wells and the collection and analysis of additional groundwater samples, the overall volume of the groundwater plume should not be significantly different.

As previously mentioned, TRPHs were detected in sediment samples collected from the ditch and outfall located downgradient of tank 39-J. It is probable that the sediment contamination is a result of previous releases of petroleum, and not from ongoing migration of petroleum into the surface water bodies. TRPHs were not detected in surface water samples collected at the same locations. This indicates that significant migration of petroleum to adjacent surface drainage systems through discharges of ground water via seeps or base flow was not occurring at the time of sampling.

As discussed in Section 2.0, the shallow aquifer at NAVBASE Charleston is not utilized for potable water supply. The specific conductivity of the ground water samples suggests that the ground water in the vicinity of the Base Tank Farm is high in total dissolved solids, likely due to adjacent saline waters. This ground water, therefore, is not suitable for potable use, agricultural use, or irrigation.

No primary or secondary drinking water criteria exists for the PAH compounds detected in the ground water at this site. EPA has, however, derived criteria that relate ingestion of water containing PAH compounds to an incremental risk level for these potential carcinogenic compounds. These criteria are based on an intake of 2 liters/day over a lifetime and

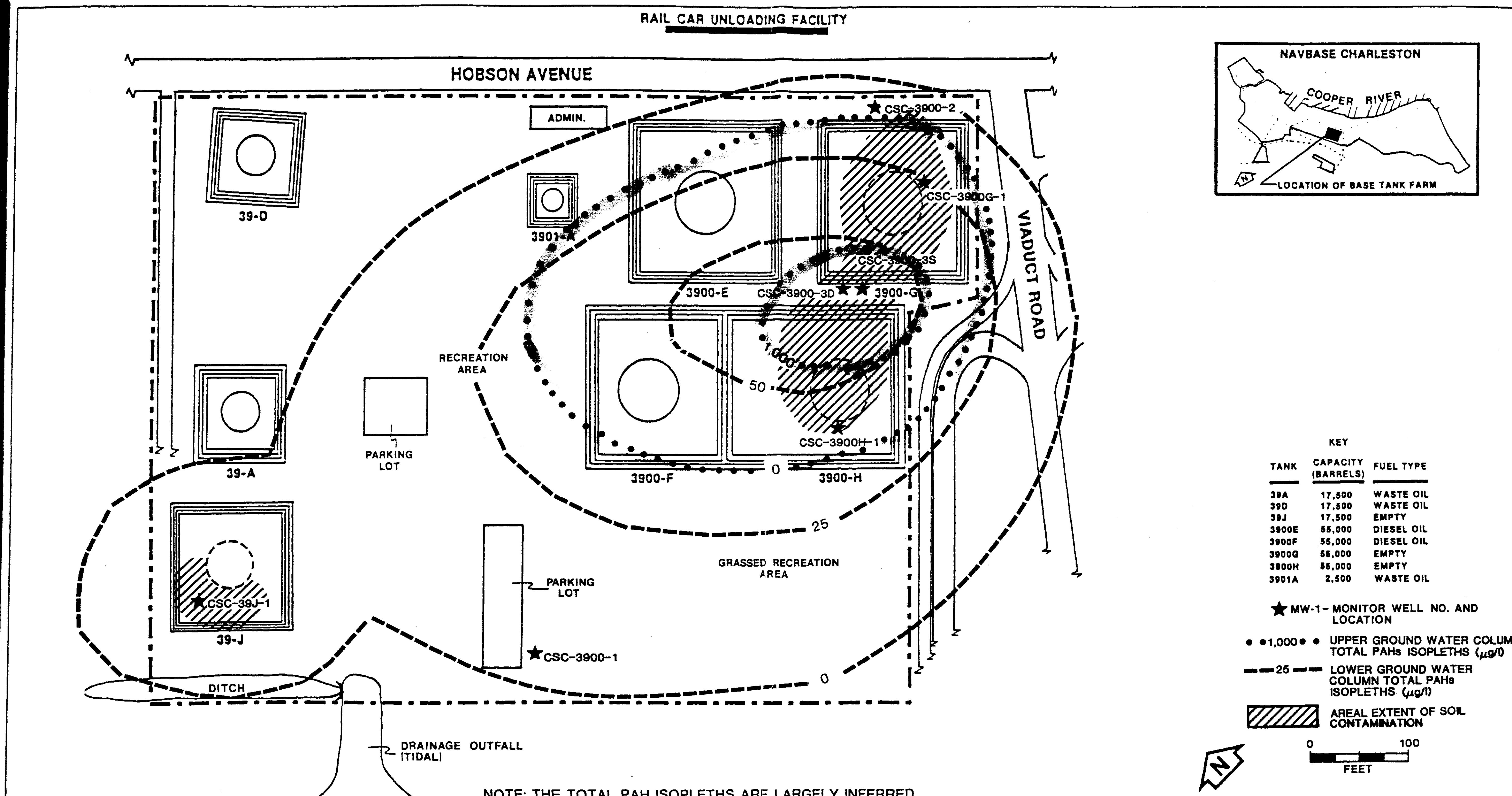


Figure 5.2-1
COMPARISON OF TOTAL PAH GROUND WATER AREAL CONTAMINATION WITH THE AREAL EXTENT OF SOIL CONTAMINATION

CHARACTERIZATION STUDY - BASE TANK FARM
NAVBASE, CHARLESTON, S.C.

a body weight of 70 kg. The criterion corresponding to a 10^{-5} incremental risk level for PAH compounds is 0.031 µg/l. Although the levels of PAH compounds detected in the surficial aquifer at this site are above this criteria, the ground water in the shallow aquifer at NAVBASE Charleston is not utilized as a potable supply; thus, the contaminants in the shallow aquifer do not appear to present an imminent human health hazard.

The petroleum contamination in the sediments of the adjacent surface drainage, however, poses a potential for adverse impacts to aquatic life, particularly benthic organisms. Benthic organisms live and feed in the sediments of aquatic systems and are less mobile than other aquatic life (e.g. fish). Studies (Moore et. al., 1973) have indicated that toxicity to benthic organisms occur at concentrations from 5 to 50 mg/kg (No. 2 fuel oil); 100 to 6,100 mg/kg (fresh crude); and 2,000 to 2,500 mg/kg (residual oils). Concentrations observed in the sediments during this investigation ranged from 43.9 to 268 mg/kg. [illegible] residues in the sediments, therefore, could potentially [illegible] the diversity of the benthic biological community.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Petroleum release from tanks 3900-G, 3900-H, and 39-J has caused contamination of soils, ground water, and sediment in the vicinity of the Base Tank Farm. The contamination does not represent, in its present state, an imminent hazard to human health, however, the petroleum-contaminated soils in the vicinity of tanks 3900-G, 3900-H and 39-J are a continuing source of contaminants to the ground water. Release of contaminants occurs via leaching by percolating rainwater and/or saturation of the contaminated soil by water table fluctuations.

The State of South Carolina DHEC has generally classified all ground waters of the state as Class GB (if the dissolved solids content is less than 10,000 mg/l). The numeric water quality standards for Class GB ground water are the primary drinking water MCLs. In considering recommendations for subsequent actions at this site, it was noted that The State of South Carolina DHEC will grant a mixing zone upon demonstration that:

(1) reasonable measures have been taken or binding commitments are made to minimize the addition of contaminants to ground water and/or control the migration of contaminants in ground water; and

(2) the ground water in question is confined to the uppermost aquifer which has little or no potential of being an Underground Source of Drinking Water (USDW), and discharge or will discharge to surface waters without contravening surface water standards; and

(3) the contaminant(s) in question occurs on the property of the applicant, and there is minimum possibility for ground water withdrawals (present or future) to create drawdown such that contaminants would flow off-site; and

(4) the contaminants or combination of contaminants in question are not dangerously toxic, mobile, or persistent.

The surficial aquifer at NAVBASE Charleston is not being utilized as drinking water source. The potential for migration in the surficial aquifer is lateral towards the Cooper River. The Cooper marl with an estimated thickness of 200 ft, forms an effective confining zone underneath the surficial aquifer. Because of this thick confining zone, there is minimal potential for the contamination in the surficial aquifer to reach the Santee Limestone which underlies the Cooper formation at a depth of over 225 BLS.

Recommended remedial actions are as follows:

(1) Since the petroleum contaminated soils provide a potential continuing source of contaminants to the ground water, it is recommended that a focused feasibility study be performed to determine the most technically feasible methodology for site rehabilitation. At a minimum, remedial alternatives should include consideration of the following:
   - o Excavation of soils identified as having petroleum contamination in the vadose zone in former tank areas 3900-G, 3900-H and 39-J. Following testing of the soil for hazardous characteristic, soil disposal should be at an approved waste disposal facility. After removal of these contaminated soils, clean fill should be placed in the area.

(2) Based on the results of the focused feasibility study, develop a Remedial Action Plan and following approval of the RAP, implement the remedial alternative selected.

(3) Following remedial action at the site, a ground water monitoring plan utilizing the existing monitor wells should be developed and submitted to DHEC. It is anticipated that once the principal source of contaminants are removed (i.e., the petroleum-saturated soils), restoration of ground water quality at the BTF will occur. All soil that shows visible evidence of

↳ Intend GW

Leaving hazardous constituents in GW to eventually migrate offsite, dissipate or be degraded by natural processes does not constitute remedial action.

hydrocarbon contamination (i.e. petroleum-saturated soils) or exhibits a head space reading of $\geq$5 ppm on an organic vapor analyzer (OVA) equipped with a flame ionization detector should be removed. This monitoring plan will insure that the remedial action associated with contaminated soils at the site has effectively controlled any subsequent ground water contamination.

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APPENDIX A

SHALLOW SOIL BORING LOGS

APPENDIX A
NSC BASE TANK FARM
SHALLOW SOIL BORING LOGS

Boring No.	Depth	Description
G-1	0 - 1.5	Sand, brown, fine grained, minor petroleum odor.
	1.5 - 3.0	Sand, gray, visibly appears clean, petroleum odor emmitting from boring.
G-2	0 - 1.0	Sand, brown, fine grained, minor petroleum odor.
	1.0 - 1.5	Sand, orangish-brown, petroleum odor.
	1.5 - 2.5	Sand, dark gray, tar like appearance, strong petroleum odor.
G-3	0 - 1.5	Sand, light brown, minor petroleum odor.
	1.5 - 2.5	Sand, dark gray to black, some clay, strong petroleum odor.
G-4	0 - 2.0	Sand, brown, earthy odor.
	2.0 - 3.0	Sand, clayey, dark brown, no distinguishable odor.
	3.0 - 3.5	Clay, medium soft, pliable, moist, no distinguishable odor.
G-5	0 - 1.0	Sand, brown, very slight petroleum odor.
	1.0 - 2.5	Sand, clayey, black, strong petroleum odor (no clay encountered).
G-6	0 - 0.5	Sand, brown, earthy.
	0.5 - 2.5	Sand, clayey, dark grayish brown, visibly appears contaminated with tar like substance, possible slight petroleum odor.

Boring No.	Depth	Description
G-7	0 - 1.0	Sand, gray, very minor petroleum odor.
	1.0 - 1.5	Sand, very clayey, orange, minor petroleum odor.
	1.5 - 3.0	Sand, dark gray, minor petroleum odor, slightly clayey, moist.
G-8	0 - 1.5	Sand, brown, no distinguishable odor.
	1.5 - 2.8	Sand, grayish brown, earthy odor.
	2.8 - 3.2	Sandy clay, very dark gray, possibly some petroleum deposit at top of clay.
G-9	0 - 1.5	Sand, grayish brown, fine grained, no distinguishable odor.
	1.5 - 2.5	Sand, light gray, fine grained, no distinguishable petroleum odor.
	2.5 - 3.0	Sand, gray, no distinguishable odor.
G-10	0 - 3.0	Sand, brown, very minor petroleum odor near 3 feet, becoming more clayey with grayish green clay at bottom of hole.
G-11	0 - 1.5	Sand, brown, minor petroleum odor.
	1.5 - 3.0	Sand, dark grayish brown, strong petroleum odor.
	3.0 - 3.5	Clay, very dark gray, minor petroleum odor at 3 feet, no odor at 3.5 feet.
G-12	0 - 1.0	Sand, brown, dirty, slight petroleum odor.
	1.0 - 3.0	Sand, dark grayish brown, minor clay, strong petroleum odor.
H-1	0 - 1.5	Sand, brown, dirty, petroleum odor.
	1.5 - 3.0	Clay, sandy. oil, tar like, very dark gray, petroleum odor.

Boring No.	Depth	Description
H-2	0 - 1.0	Sand brown, slightly clayey, dirty, stained, slight petroleum odor.
	1.0 - 2.5	Clay, dark gray to black, oily residue, tarry, moderate petroleum odor.
	2.5 - 3.0	Clay, slightly snady, light greenish brown, does not appear visually contaminated, no distinguishable odor.
H-3	0 - 1.5	Sand, grayish brown, moderate petroleum odor.
	1.5 - 2.0	As above, black stained from 1.6 to 1.8 feet.
	2.0 - 2.5	Clay, blue green, stiff, no distinguishable odor.
H-4	0 - 1.5	Sand, grayish brown, no distinguishable odor.
	1.5 - 3.0	Clay, blue, clean, stiff, no distinguishable odor.
H-5	0 - 1.5	Sand, fine grained, brown, no distinguishable odor.
	1.5 - 2.0	Sand, clayey, grayish brown, no distinguishable odor.
	2.0 - 3.0	Clay, orangish-brown, no distinguishable odor, interbedded gray sandy lenses.
H-6	0 - 1.0	Sand, brown, slight petroleum odor.
	1.0 - 2.5	Sand, clayey, dark gray to black, strong petroleum odor.
	2.5 - 3.0	Sand, very dark gray, petroleum odor, minor greenish sandy clay at boase of hole.

Boring No.	Depth	Description
H-7	0 - 2.5	Sand, brown, earthy oror, increasing clay with depth.
	2.5 - 3.0	Sandy clay, dark grayish-blue, no distinguishable odor.
J-1	0 - 1.0	Sand, brown, fine grained, no distinguishable odor.
	1.0 - 2.0	Sand, clayey, brownish gray, no distinguishable odor.
	2.0 - 3.0	Clay, snady, grading to blue clay, stiff, no distinguishable odor.
J-2	0 - 1.0	Sand, brown, fine grained, no distinguishable odor.
	1.0 - 2.0	Sand, clayey, brownish gray, no distinguishable odor.
	2.0 - 3.0	Sandy clay, grading to blue stiff clay, no distinguishable odor.
J-3	0 - 1.0	Sand, brown, fine grained.
	1.0 - 2.0	Sand, clayey, brownish gray.
	2.0 - 3.0	Clay, snady, gray, grading to blue clay, stiff. Note: distinguishable "burnt" odor.
J-4	0 - 1.0	Sand, brown, fine grained, slight petroleum odor.
	1.0 - 2.0	Sand, clayey, brownish gray, petroleum odor.
	2.0 - 3.0	Sandy clay, gray, moist, strong petroleum odor.

Boring No.	Depth	Description
J-5	0 - 1.0	Sand, brown, fine grained, slight petroleum odor.
	1.0 - 2.0	Sand, clayey, brownish gray, slight petroleum odor.
	2.0 - 3.0	Sandy clay, gray, damp, moderate petroleum odor.
J-6	0 - 1.0	Sand, brown, fine grained, no distinguishable odor.
	1.0 - 2.0	Sand, clayey, brownish gray, firm, no distinguishable odor.
	2.0 - 3.0	Sandy clay, gray, hard, brittle, grading to blue stiff clay, no distinguishable odor.
J-7	0 - 1.0	Sand, brown, fine, moist, very strong petroleum odor.
	1.0 - 2.0	Sand, clayey, brownish grey, mosit very strong petroleum odor.
	2.0 - 3.0	Sandy clay, bluish green, moderate petroleum odor.
	3.0 - 3.5	Clay, blue-green, v. slight petroleum odor.
J-8	0 - 1.0	Sand, brown, fine, low moisture, minor petroleum odor.
	1.0 - 2.0	Sand, clayey, brownish gray, minor petroleum odor.
	2.0 - 3.0	Clay, bluish green, v. slight petroleum odor.
J-9	0 - 1.0	Sand, brown, fine, dry, v. faint petroleum odor, almost nondistinguishable.
	1.0 - 2.0	Same as above.
	2.0 - 3.0	Sandy clay, bluish green, no distinguishable odor.

APPENDIX B

MONITOR WELL BORING LOGS

AAAP 10/4/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. 86-714

BTF-1

Client NAVFACENGCOM

Project LUST - BASE TANK FARM

Boring No. CSC-3900-1 Date 28 JULY 86 Sheet ___ of ___

Type of Boring Monitor Well Track Mant - Auger

Casing used ___ Size ___ Drilling mud used ___

Boring begun ___ Boring completed ___

Ground Elevation ___ referred to ___ Datum

Field Party: SLK

Location of Boring: UPGRADIENT - CORNER OF BASEBALL FIELD	
Water Level	
Time	
Date	

Depth of Casing, Ft.	Sample No.	Sample Depth (from-to) (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0		Top Soil, Brown, organic, trace Sand, fine
							1		
									Clay, Bluegray, damp, plastic
							5		Clay tan-orange, sandy - saturated @5
							10		SAA
							13		Sand - Yellow/Orange; very fine, clayey- 20% water
							14		
							15		
									SAA
							20		SAA Very Very wet @ N 23'
							25		

Signed ___ Date ___

Approved ___ Date ___

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. ______

Client NAV FAC ENG COM   Boring No. CSC-3900-2   Date 7/28/86   Sheet ___ of ___

Project BASE TANK FARM   Type of Boring Auger   Rig CME 45

Casing used PVC   Size 2"   Drilling mud used None

Boring begun 1415   Boring completed 1450

Ground Elevation ______ referred to ______ Datum

Field Party: DS/SLK

Location of Boring:	
Water Level	9.5 ' BLS
Time	0830
Date	7/29/86

Depth of Casing, Ft.	Sample No.	Sample Depth (from-to) (In Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0	SA	0-2; Sand, Brn, Fine, Silty
									2-4; Sand; v. dk gray - black, pet. odor
							5	Clay	4-5; Clay, silty, dk gray-black, minor petrol. odor
									5-7.5; Same as Above
									7.5-8; Clay, greenish brn, sandy dense
							10		8-10 Clay, Sandy, black, no odor tarlike (goop)
									10-15; Clay, silty, v. soft, moist v. sticky, v. dk gray to black
							15	SILT	15-20; Clayey Silt, v. soft lighter than above, more moisture, sulfer oder, organic, v. sticky
							20	CLAYEY	20-25; Clayey Silt, Muck, v. soft, wet, v. sticky, dk gray, sulfer oder
							25		

Signed ______ Date ______

Approved ______ Date ______

AAAP 10/4/86

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No.

Client Navy

Project Base Tank Farm

Boring No. CSC-3900-3D Date 7/29/86 Sheet ___ of ___

Type of Boring Auger Rig CME 45 Track Move

Casing used PVC Size 2" Drilling mud used None

Boring begun 0815 Boring completed 0845

Ground Elevation ___ referred to ___ Datum

Field Party:

Location of Boring:	Off Asphalt read betw. Pad "G" and Pad "N"
Water Level	
Time	
Date	

Depth of Casing, Ft.	Sample No.	Sample Depth (from-to) (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0	sa	0-1 Sand, brn minor pet.odor
									1-3 Sand & concrete dk grayish brn strong pet. odor
							5		3-5 Sand, v. fine-clayey, v. dk gray to blk, strong pet oder some concrete frag's
									8-10 Silty to clayey muck, very sticky non pliable, high moisture, v. dk gray to black, mod. pet. odor
							10		10-15 Muck as above, moist v. sticky soft, dk gray, bl. pet odor, non pliable
							15		15-20 As above; black mucky silt 5-109. sand 40-50% silt, 30% clay v. sticky, organic beginning to pick up sulfur odor
									20-22 Clay, blue green, medium dense, cohesive, pliable
							20		22-25 Sillty Marl and v. fine sand w/ 20% clay content v. soft to soupy, water bearing zone, greenish gray.
							25		

Signed ___ Date ___

Approved ___ Date ___

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. ____________________

Client NAVFACENGCOM　　Boring No. CSC-3900-3S　　Date 7/29/86　　Sheet ____ of ____

Project Base Tank Farm　　Type of Boring Auger　　Rig CME 45

Location of Boring: Betw. "G" & "H"　　Casing used PVC　Size 2"　Drilling mud used None

Water Level　　Boring begun 0955　　Boring completed 1010

Time　　Ground Elevation ________ referred to ________ Datum

Date　　Field Party: D. Smoak; S. Klinzing

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (Inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0	Sa	0-2; Sand gr. brown, dirty, petroleum odor
									2-5; Clayey sand, v. dk gray-black, strong petrol odor, tarlike, concrete frags.
							5	CL SA	5-6; Same as Above
									6-10; Clayey Sand; becoming, sticky & Mucky @ 8 Ft.; moist; pet odor 6-7 (predom concrete frags) black
							10		
								MUCK	10-15; Silty Muck; black, v. sticky Moist
							15		

Signed ____________________ Date ________

Approved ____________________ Date ________

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. ____

Client NAVFACENGCOM Boring No. CSC-3900G-1 Date 7/29/86 Sheet ___ of ___

Project BASE TANK FARM Type of Boring Auger Rig CME 45

Location of Boring:	5 FT E. side Pad "G"
Water Level	4-5 FT. Bls
Time	1140
Date	7/29/86

Casing used PVC Size 2" Drilling mud used None

Boring begun 1130 Boring completed 1205

Ground Elevation ____ referred to ____ Datum

Field Party: D. Smoak/ S. Klinzing

Depth of Casing, Ft.	Sample No.	Sample Depth from-to (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0		0-1: Sand, gr-brn, pet. odor
									2-4: Silty Sand, v. dk gray, strong petroleum odor, minor clay (5%)
							5		4-9: Muck, silty-Sandy, soupy v. dark gray, wet, minor pet. odor; emulsification observed.
							10		9-14: As above; emulsified secretion, pet. sheen from muck.
							15		14-18 As above, dark gray muck pet. emulsification
							20		18-19 Clay, green-gray, med. soft, pliable
									NOTE: Petroleum emulsifications oozing from borehole materials.

Signed ____ Date ____

Approved ____ Date ____

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. ______

Client NAVFACENGCOM

Project BASE TANK FARM

Boring No. CSC-3900H-1 Date 7/30/86 Sheet ___ of ___

Type of Boring Auger Rig CME 45

Casing used PVC Size 2: Drilling mud used None

Boring begun 0900 Boring completed 0920

Ground Elevation ______ referred to ______ Datum

Field Party: David Smoak

Location of Boring:	West side of Pad "H"
Water Level	5 FT BLS
Time	0910
Date	7/30/86

Depth of Casing, Ft.	Sample No.	Sample Depth (from-to) (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPHIC	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wash water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0	SA	0-2; Sand, dirty brown, fine petroleum odor, some concete frags
							5	SACL	2-5; Sandy Clay, v. dark gray, Petroleum odor
								MUCK	5-7; Silty sand, Muck, v. wet v. minor petrol. odor (perched) W.T.
							10		7-9.5; Clay, med dense, pliable, gray-blue, no dist. odor
								CLAY	9.5-14.5; Clay, v. dense, dry, blue with orange streaks, pliable, no odor
							15	MARL	14.5-15; Marl, greenish-gray, wet

Signed ______ Date ______

Approved ______ Date ______

AAAP 10/4/85

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

Job No. ____

Client NAVFACENGCOM

Project Base Tank Farm

Location of Boring: West side of Tank Platform "J"	
Water Level	12.67' BLS
Time	1230
Date	7-31

Boring No. CSC-39J-1 Date 7/30/86 Sheet ___ of ___

Type of Boring Auger Rig CME 45

Casing used PVC Size 2" Drilling mud used None

Boring begun 1500 Boring completed 1520

Ground Elevation ____ referred to MLW Datum

Field Party: David Smoak

Depth of Casing, Ft.	Sample No.	Sample Depth (from to) (in Feet)	Blows/Foot on Sampler	ID of Sampler (inches)	Tot. Length of Recov. Sample	USCS Classification	DEPTH IN FEET	SOIL GRAPH	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths wasn water lost, observed fluctuations in water level, notes on drilling ease, etc.
							0	SA	0-1; Sand, Fine, brn, soft, slight petroleum odor
								CL	2-4; Clay, sandy, blue-green, moist, strong petroleum odor
							5		4-4.5 Clay; v. dk gray, dry, stiff
								CLAY	4.5-9.5; Clay gray, v. little moisture, stiff pliable, no existing odor
							10		9.5-14.5; Silty sandy clay, dk gray, no distinguishable odor, moderate moisture, sticky muck
							15	MUCKY	15-18; clayey Muck, not as clayey as above, moderate moisture
							20	MUCK	

Signed ____ Date ____

Approved ____ Date ____

APPENDIX C

MONITOR WELL CONSTRUCTION LOGS

AAAP 10/4/85

MONITOR WELL CONSTRUCTION

Logged By: SK

Drilling Contractor: Soil Consultants

Driller's Name: Bubba

Well Number: CSC-3900-1

Client: NAVFACENGCOM - South Div

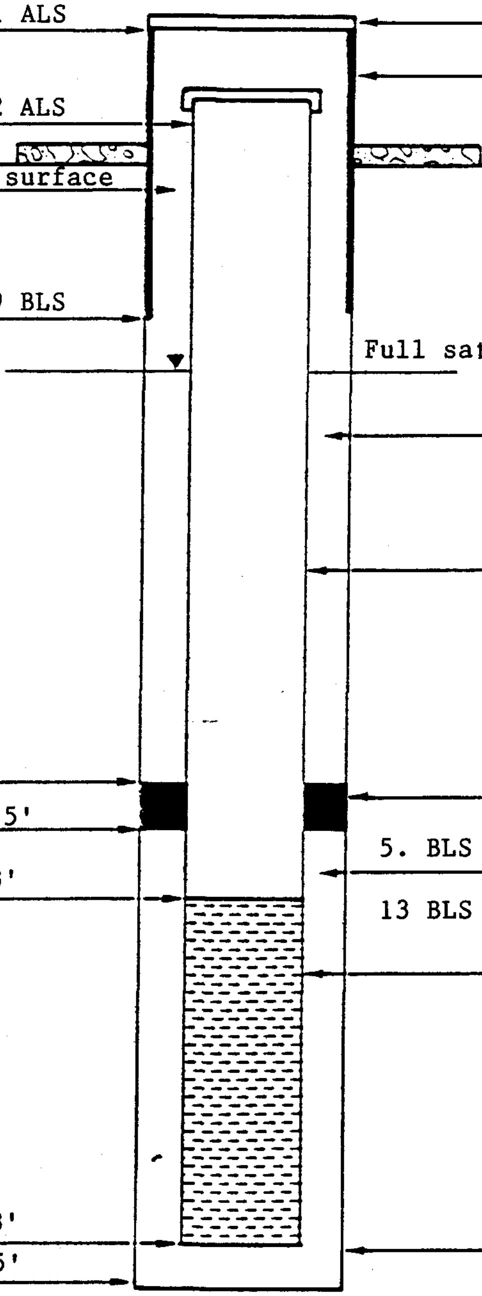
Location: NSC - Base Tank Farm

Job Number: 86-714

Date/Time: Start 10:30 Finish

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing 2.1 ALS

Top of Well Casing 2 ALS

Top of Cement Land surface

Bottom of Protective Casing 2.9 BLS

Ground Water — Full saturation ZO'

Top of Bentonite Seal 3'

Top of Gravel Pack 5'

Top of Screen 13'

Bottom of Screen 23'

Total Depth of Bore Hole 25'

Locking Cap

Protective Pipe Type, Diameter: Steel, 4½"

Cement/Gravel Pad

Type of Grout: Portland Type I

Casing:
- Type: PVC - Threaded
- Diameter: 2"

Couplings:
- Type: NA Threaded
- Number: 2
- Depths: 3 ; 13

Type of Plug: Brainard-Killman Geo Pellets

Gravel Pack: 5. BLS – 13 BLS
- Material: Sand-coarse quartz

Screen:
- Type: PVC- Threaded
- Diameter: 2"
- Length: 10'
- Slot Size: .011

Bore Hole Diameter: 6"

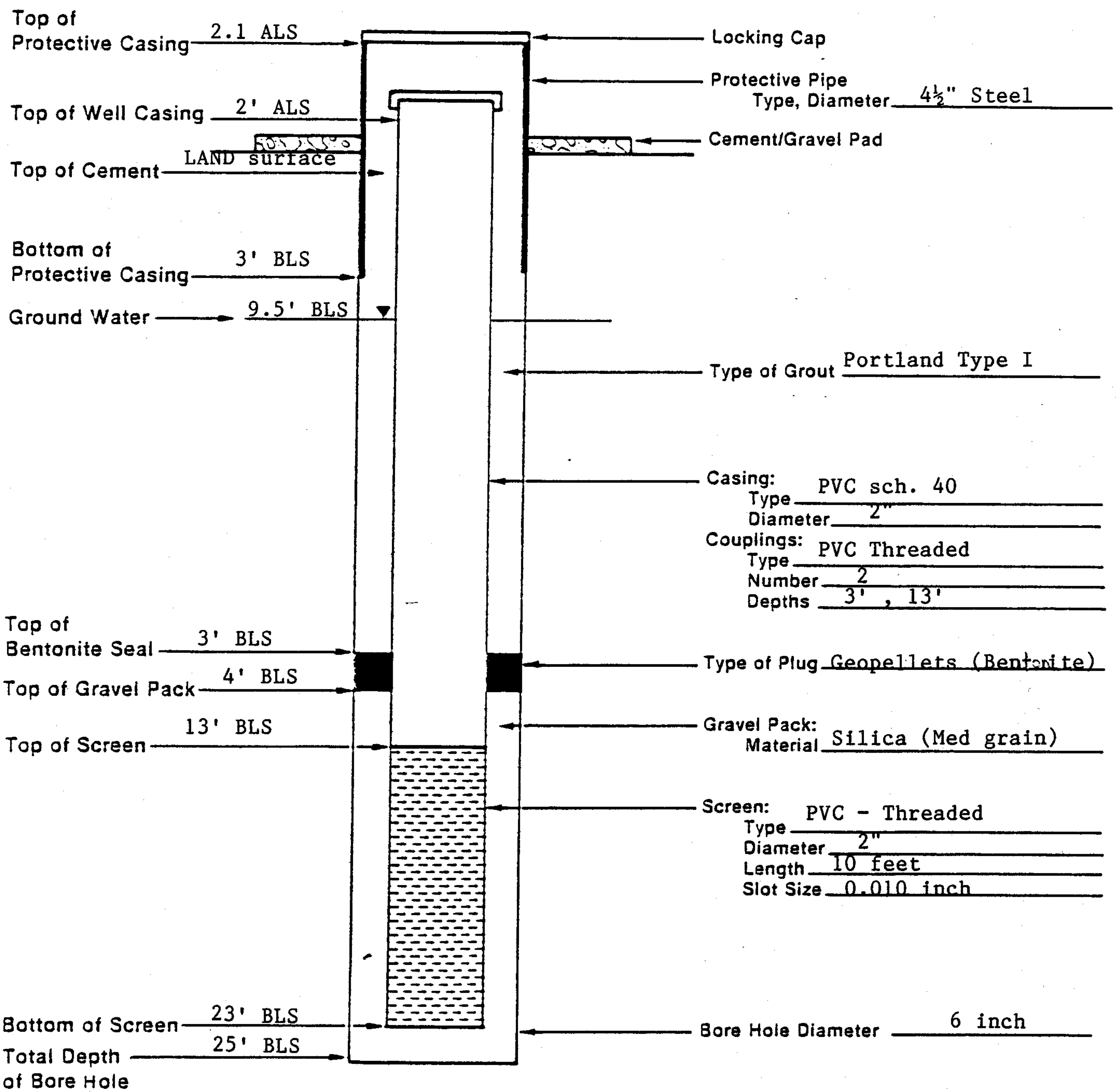
NOT TO SCALE

AAAP 10/4/85

MONITOR WELL CONSTRUCTION

Logged By: DS/SK
Client: NAVFACENGCOM
Drilling Contractor: Soil Consultants
Location: Base Tank Farm
Driller's Name: James Middleton
Job Number:
Well Number: CSC-3900-2
Date/Time: Start 1400 Finish 1500
Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



NOT TO SCALE

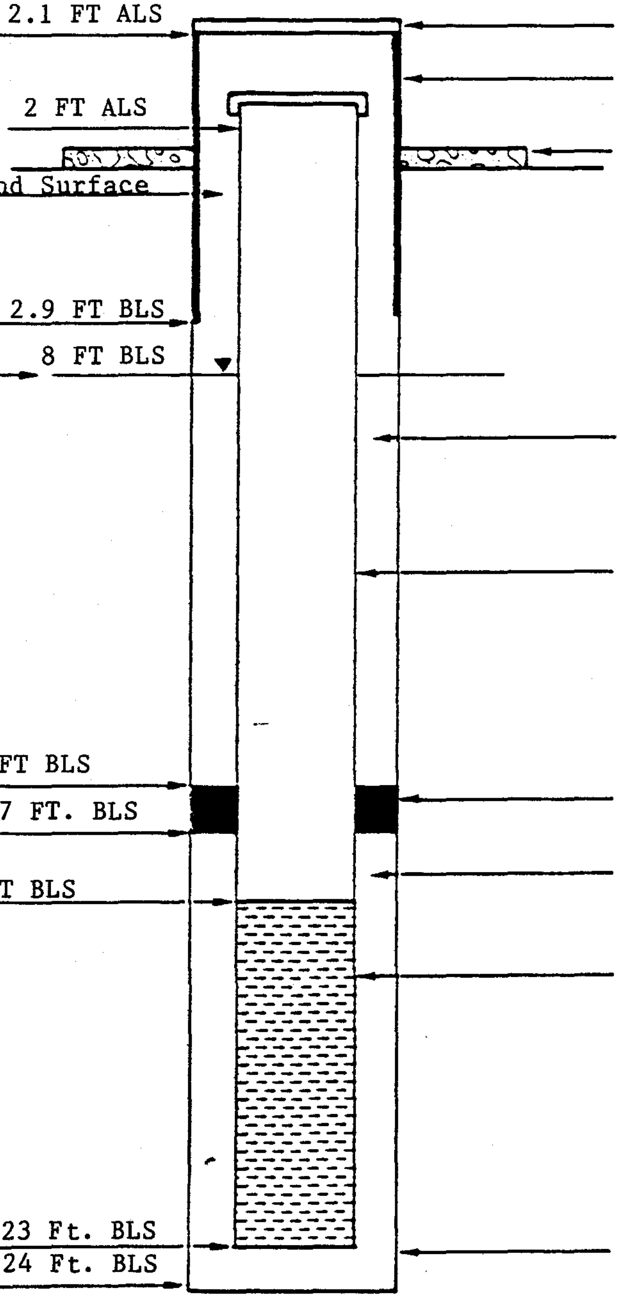
AAAP 10/4/85

MONITOR WELL CONSTRUCTION

Logged By: D. Smoak
Client: NAVFACENGCOM
Drilling Contractor: Soil Consultant's
Location: Base Tank Farm
Driller's Name: James Middleton
Job Number: Lust
Well Number: CSC-3900-3D
Date/Time: Start 0815 Finish 0910

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



Top of Protective Casing: 2.1 FT ALS
Top of Well Casing: 2 FT ALS
Top of Cement: Land Surface
Bottom of Protective Casing: 2.9 FT BLS
Ground Water: 8 FT BLS
Top of Bentonite Seal: 5 FT BLS
Top of Gravel Pack: 7 FT. BLS
Top of Screen: 13 FT BLS
Bottom of Screen: 23 Ft. BLS
Total Depth of Bore Hole: 24 Ft. BLS

Locking Cap

Protective Pipe Type, Diameter: 4½ inch

Cement/Gravel Pad

Type of Grout: Portland Type I

Casing:
Type: PVC
Diameter: 2 inch

Couplings:
Type: PVC Threaded
Number: 2
Depths: 13 Ft., 3 Ft.

Type of Plug: Geopellet/Bentonite

Gravel Pack:
Material: Med. grain silica

Screen: TYMCO PVC slotted
Type
Diameter: 2 inch
Length: 10 feet
Slot Size: .010 inch

Bore Hole Diameter: 6 inches

NOT TO SCALE

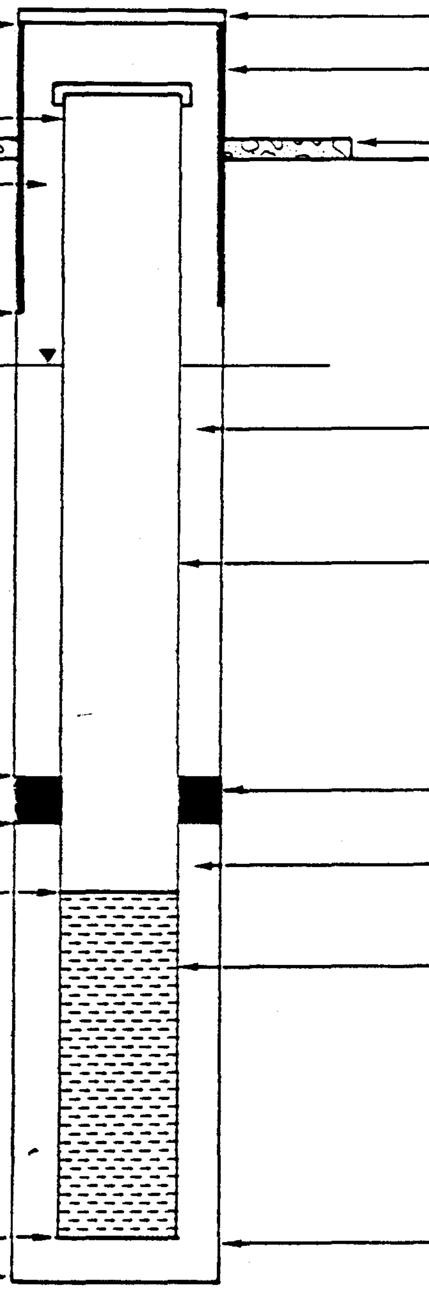
AAAP 10/4/85

MONITOR WELL CONSTRUCTION

Logged By: D. Smoak
Client: Navfacengcom
Drilling Contractor: Soils Consultants
Location: Base Tank Farm
Driller's Name: James Middleton
Job Number:
Well Number: CSC-3900-3S
Date/Time: Start 0955 Finish 1045
7/29/86
Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Very low permerbility - little water

Depths in Reference to Ground Level



Top of Protective Casing: 1.5 ALS
Top of Well Casing: 1' ALS
Top of Cement: Land Surface
Bottom of Protective Casing: 3.5 FT BLS
Ground Water: 4 FT BLS
Top of Bentonite Seal: 2 FT BLS
Top of Gravel Pack: 3 FT BLS
Top of Screen: 4 FT BLS
Bottom of Screen: 14 FT BLS
Total Depth of Bore Hole: 15 FT BLS

Locking Cap
Protective Pipe Type, Diameter: 6 inch
Cement/Gravel Pad
Type of Grout: Portland - Type I
Casing: Type: TYMCO PVC; Diameter: 2 inch
Couplings: Type: Threaded; Number: 1; Depths: 4' BLS
Type of Plug: "Geopellets" (Bentonite)
Gravel Pack: Material: Silica; Med. grained
Screen: Type: PVC Slotted; Diameter: 2 inch; Length: 10 feet; Slot Size: .010 inch
Bore Hole Diameter: 6 inch

NOT TO SCALE

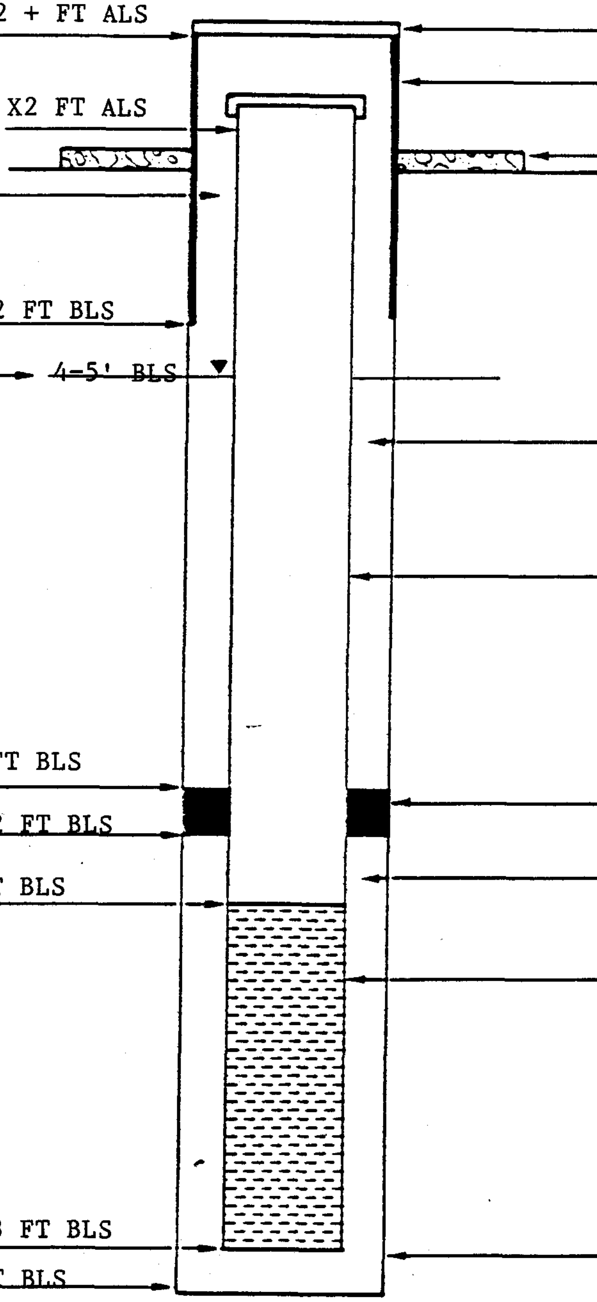
MONITOR WELL CONSTRUCTION

Logged By: D. Smoak
Client: NAVFACENGCOM
Drilling Contractor: Soil Consultants
Location: Base Tank Farm "PAD G"
Driller's Name: James Middleton
Job Number:
Well Number: CSC-3900G-1
Date/Time: Start 11:30 Finish 12:45 7/29/86

Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Petroleum sheen and emulsification observed in boring material; Water Table encountered at shallower depth than at other borings.

Depths in Reference to Ground Level



Top of Protective Casing: 2 + FT ALS

Top of Well Casing: X2 FT ALS

Top of Cement

Bottom of Protective Casing: 2 FT BLS

Ground Water: 4-5' BLS

Top of Bentonite Seal: 1 FT BLS

Top of Gravel Pack: 2 FT BLS

Top of Screen: 3 FT BLS

Bottom of Screen: 13 FT BLS

Total Depth of Bore Hole: 15 FT BLS

Locking Cap

Protective Pipe Type, Diameter: 6 inch

Cement/Gravel Pad

Type of Grout: Portland - Type I

Casing:
Type: PVC TYMCO
Diameter: 2 inch

Couplings:
Type: PVC Threaded
Number: 1
Depths: 3 FT BLS

Type of Plug: Geopellets (Bentonite)

Gravel Pack:
Material: Silica; Med Grained
2¼ Bags

Screen:
Type: PVC TYMCO - Slotted
Diameter: 2 inch
Length: 10 feet
Slot Size: .010 inch

Bore Hole Diameter: 6 inch

NOT TO SCALE

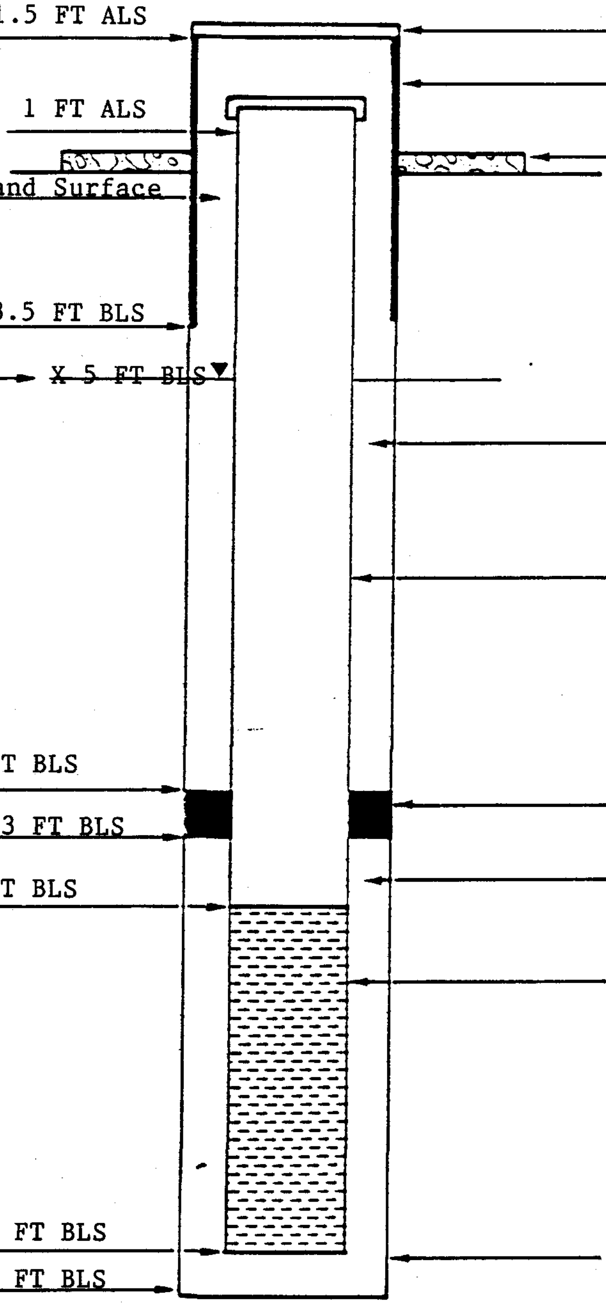
AAAP 10/4/85

MONITOR WELL CONSTRUCTION

Logged By: D. Smoak
Client: NAVFACENGCOM
Drilling Contractor: Soils Consultants
Location: Base Tank Farm
Driller's Name: James Middleton
Job Number:
Well Number: CSC-3900H-1
Date/Time: Start 0900 Finish 1000 7/30/86
Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Possible Perched W.T.

Depths in Reference to Ground Level



Top of Protective Casing: 1.5 FT ALS
Top of Well Casing: 1 FT ALS
Top of Cement: Land Surface
Bottom of Protective Casing: 3.5 FT BLS
Ground Water: ~~X 5 FT BLS~~
Top of Bentonite Seal: 2 FT BLS
Top of Gravel Pack: 3 FT BLS
Top of Screen: 4 FT BLS
Bottom of Screen: 14 FT BLS
Total Depth of Bore Hole: 15 FT BLS

Locking Cap
Protective Pipe Type, Diameter: 6 inch
Cement/Gravel Pad
Type of Grout: Portland - Type I
Casing: Type: PVC sch 40
Diameter: 2 inch
Couplings: Type: Threaded
Number: 1
Depths: 4 FT BLS
Type of Plug: Geopellets
Gravel Pack: Material: Silica med Grained
Screen: Type: PVC Slotted
Diameter: 2 inch
Length: 10 Feet
Slot Size: .010 inch
Bore Hole Diameter: 6 inch

NOT TO SCALE

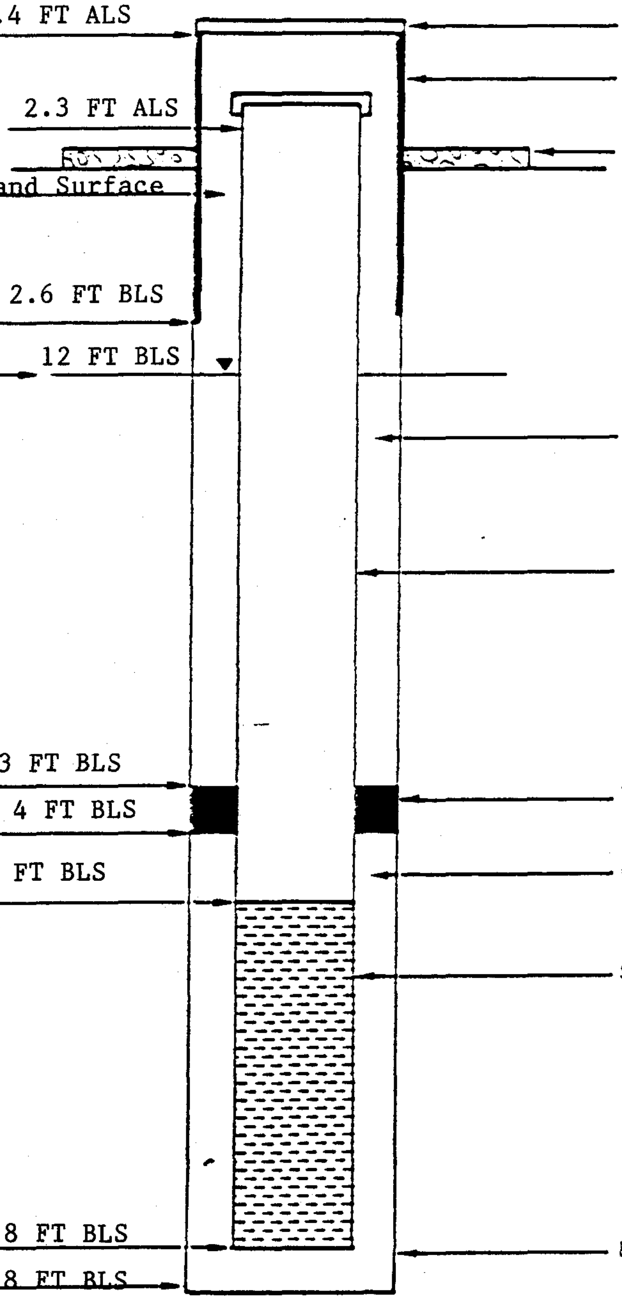
AAAP 10/4/85

MONITOR WELL CONSTRUCTION

Logged By: D. Smoak
Client: NAVFACENGCOM
Drilling Contractor: Soil Consultants
Location: Base Tank Farm "J" Platform
Driller's Name: James Middleton
Job Number:
Well Number: CSC-39J-1
Date/Time: Start 1505 Finish 1600
Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.): 7/30/86

No good water bearing 3 ones
Mostly day, sticky muck, draught conditions

Depths in Reference to Ground Level



Top of Protective Casing: 2.4 FT ALS
Top of Well Casing: 2.3 FT ALS
Top of Cement: Land Surface
Bottom of Protective Casing: 2.6 FT BLS
Ground Water: 12 FT BLS
Top of Bentonite Seal: 2.3 FT BLS
Top of Gravel Pack: 4 FT BLS
Top of Screen: 8 FT BLS
Bottom of Screen: 18 FT BLS
Total Depth of Bore Hole: 18 FT BLS

Locking Cap
Protective Pipe Type, Diameter: 6" Steel (Box Lid)
Cement/Gravel Pad
Type of Grout: Portland Type I
Casing:
Type: PVC sch 40
Diameter: 2 inch
Couplings:
Type: PVC Threaded
Number: 2
Depths: 3', 8'
Type of Plug: "Geopellets" (Bentonite)
Gravel Pack: Material: Silica-Medium grained
Screen:
Type: PVC Threaded "Triloc"
Diameter: 2 inch
Length: 10 feet
Slot Size: 0.010 inch
Bore Hole Diameter: 6 inch

NOT TO SCALE

APPENDIX D

SAMPLE CHAIN-OF-CUSTODY FORMS

CLUST2

ENVIRONMENTAL SCIENCE & ENGINEERING 06-26-86 *** FIELD LOGSHEET *** FIELD GROUP ~~NWS2SE~~

PROJECT NUMBER ~~86000-0800~~ PROJECT NAME: NAVY ~~NWS~~ C-CLUST-2- LAB COORD. ~~LION DAN~~ Jeff Shaw

NWS2SE

SE #	BTF SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST
*21	5B2 ~~NBA-SE5~~ CSS-2		SS SS SS SV SV	30 ~~29~~ July	1048	CLUST2
*22	3 ~~NBA-SE6~~ CSS-3		SS SS SS SV SV	29 July	1400	
*23	4 ~~NBA-SE7~~ CSS-4		SS SS SS SV SV	29 July	1450	
*24	5 ~~PRA-SE1~~ CSS-5		SS SS SS SV SV	29 July	1430	
*25	6 ~~PRA-SE2~~ HSS-1		SS SS SS SV SV	29 July	1510	
*26	7 ~~PRA-SE3~~ HSS-2		SS SS SS SV SV	29 July	1530	
*27	PRA-SE4		SS SS SS SV SV			
*28	PRA-SE5		SS SS SS SV SV			
*29	PRA-SE6		SS SS SS SV SV			
*30	PCP-SE1		SS SS SS SV SV			
*31	PCP-SE2		SS SS SS SV SV			
*32	PCP-SE3		SS SS SS SV SV			
*33			SS SS SS SV SV			
*34			SS SS SS SV SV			
*35			SS SS SS SV SV			

8/29

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE,TIME,FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

	RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	RECEIVED BY (NAME/ORGANIZATION/DATE/TIME)
1	Robert R. Burk/ESE/30 July 86/1650	J Shaw ESE 7/31 1220
2		
3		

OTHER FIELD NOTES FOR FIELD GROUP NWS2SE:

"control charts req'd"

ENVIRONMENTAL SCIENCE & ENGINEERING 06-26-86 *** FIELD LOGSHEET *** FIELD GROUP: ~~NWS2SE~~ CLUST2

PROJECT NUMBER ~~86000-0000~~ PROJECT NAME: NAVY ~~NWS~~ C-CLUST-2 LAB COORD. ~~LISA BARE~~ Jeff Shamis

NWS2SE

8/29

E #	SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST
*1	~~SSL-SE1~~		SS SS SS SV SV	2		
*2	SSL-SE2		SS SS SS SV SV			
*3	SSL-SE3		SS SS SS SV SV			
*4	SSL-SE4		SS SS SS SV SV			
*5	SSL-SE5		SS SS SS SV SV			
*6	SSL-SE6		SS SS SS SV SV			
*7	SSL-SE7		SS SS SS SV SV			
*8	SSL-SE8		SS SS SS SV SV			
*9	NSL-SE1		SS SS SS SV SV			
*10	NSL-SE2		SS SS SS SV SV			
*11	NSL-SE3		SS SS SS SV SV			
*12	NSL-SE4		SS SS SS SV SV			
*13	NSL-SE5		SS SS SS SV SV			
*14	NSL-SE6		SS SS SS SV SV			
*15	NSL-SE7		SS SS SS SV SV			
*16	NSL-SE8		SS SS SS SV SV			
*17	NBA-SE1		SS SS SS SV SV			
*18	NBA-SE2		SS SS SS SV SV			
*19	~~NBA-SE3~~		SS SS SS SV SV			
*20	SS1 ~~[illegible]~~ QSS1		SS SS SS SV SV	30 8 ~~29~~ July	1130	CLUST2

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE,TIME,FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD: IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

	RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	RECEIVED BY (NAME/ORGANIZATION/DATE/TIME)
1	Robert R. Burk/ESE/ ~~29~~ 30 8 July 86/1650	J. Shamis ESE 7/31 1220
2		
3		

OTHER FIELD NOTES FOR FIELD GROUP NWS2SE:

D-2

ENVIRONMENTAL SCIENCE & ENGINEERING 06-26-86 *** FIELD LOGSHEET *** FIELD GROUP: NWS2SE

PROJECT NUMBER ~~86000-0000~~ PROJECT NAME: NAVY - NWS LAB COORD. ~~LISA DAR~~E

[redacted] C-LUST-2 JDS 8/29/86

ESE #	SITE/STA	HAZ?	FRACTIONS (CIRCLE)	DATE	TIME	PARAMETER LIST
27[redacted] BTF SB8	[redacted]	HSS-3	SS SS SS SV SV	7/31/86	0925	CLUST2
28[redacted] BTF SB9	[redacted]	HSS-4	SS SS SS SV SV	7/31/86	1015	
29[redacted] BTF SB10	[redacted]	HSS-5	SS SS SS SV SV	7/31/86	1030	
30[redacted] BTF SB11	[redacted]	JSS-1	SS SS SS SV SV	7/31/86	1100	
31[redacted] BTF SB12	[redacted]	JSS-2	SS SS SS SV SV	7/31/86	1115	
32[redacted] BTF SB13	[redacted]	JSS-3	SS SS SS SV SV	7/31/86	1130	
33[redacted] BTF SB14	[redacted]	JSS-4	SS SS SS SV SV	7/31/86	1145	
34[redacted] BTF SB15	[redacted]	JSS-5	SS SS SS SV SV	7/31/86	1200	
*29	~~PRA~~-SE6		SS SS SS SV SV			
*30	PCP-SE1		SS SS SS SV SV			
*31	PCP-SE2		SS SS SS SV SV			
*32	PCP-SE3		SS SS SS SV SV			
*33			SS SS SS SV SV			
*34			SS SS SS SV SV			
*35			SS SS SS SV SV			

D-3

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE, TIME, FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

	RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	RECEIVED BY (NAME/ORGANIZATION/DATE/TIME)
1	Robert Burke / ESE / 31 July 86 / 1800	J Shamro ESE 8/1/86 1330
2		
3		

OTHER FIELD NOTES FOR FIELD GROUP NWS2SE:

Samples 27-29 TANK "H" Area

Samples 30-34 TANK "J" Area

8/29

ENVIRONMENTAL SCIENCE & ENGINEERING 06-03-86 *** FIELD LOGSHEET *** FIELD GROUP: CLUST1
PROJECT NUMBER 86401V0418 PROJECT NAME: CHARLESTON LUST PROGRAM LAB COORD. JEFF SHAMIS

ESE #	SITE/STA	HAZ?	FRACTIONS(CIRCLE) CLUST1	DATE	TIME	PARAMETER LIST	CON.	D.O.	P.H.	Temp
*1			0 VP VP VP			CLUST1				
*2			0 VP VP VP			CLUST1				
*3			0 VP VP VP			CLUST1				
*4			0 VP VP VP			CLUST1				
*5			0 VP VP VP			CLUST1				
*6			0 VP VP VP			CLUST1				
*7			0 VP VP VP			CLUST1				
*8			0 VP VP VP			CLUST1				
*9			0 VP VP VP			CLUST1				
*10			0 VP VP VP			CLUST1				
*11			0 VP VP VP			CLUST1				
*12			0 VP VP VP			CLUST1				
*13	BTFSW1		0 VP VP VP	8-1-86	0900	CLUST1	1871	3.4	7.1	30.3
*14	BTFSW2		0 VP VP VP	8-1-86	0940	CLUST1	1819	4.8	9.2	32.4
*15	BTFSW3		0 VP VP VP	8-1-86	1030	CLUST1	1808	8.3	8.9	32.4
*16			0 VP VP VP			CLUST1				

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE,TIME,FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD: IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

	RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	RECEIVED BY (NAME/ORGANIZATION/DATE/TIME)
1	George Sullivan \ E.S.E. \ 8-1-86 \ 12:16 pm.	LRB/ESE 8/2/86 12a
2		J Shamis 8/4/86 8:15
3		

OTHER FIELD NOTES FOR FIELD GROUP CLUST1:

D-4

ENVIRONMENTAL SCIENCE & ENGINEERING 06-26-86 *** FIELD LOGSHEET *** FIELD [illegible] 6/29

PROJECT NUMBER 86~~000-0000~~ 401 418 PROJECT NAME: NAVY - [redacted] C-LUST-2 LAB COORD: [redacted]

[redacted] charleston lust pra \ Jeff [illegible] Shomus

ESE #	SITE/STA	HAZ?	FRACTIONS (CIRCLE)	DATE	TIME	PARAMETER LIST	
*1 BTF SE1	~~NBA-S1A~~	SE-35	SS SS SS SV SV	8-1-86	09:15	CLUST2	— Each one had broken / rebottled.
*2 BTF SE2	[redacted]	SE-36	SS SS SS SV SV	8-1-86	09:50		
*3 BTF SE3	[redacted]	SE-37	SS SS SS SV SV	8-1-86	10:40		
*4	NBA-S2B		SS SS SS SV SV				
*5	NBA-S3A		SS SS SS SV SV				
*6	NBA-S3B		SS SS SS SV SV				
*7	NBA-S4A		SS SS SS SV SV				
*8	NBA-S4B		SS SS SS SV SV				
*9	NBA-S5A		SS SS SS SV SV				
*10	NBA-S5B		SS SS SS SV SV				
*11	NBA-S6A		SS SS SS SV SV				
*12	NBA-S6B		SS SS SS SV SV				
*13	NBA-S7A		SS SS SS SV SV				
*14	NBA-S7B		SS SS SS SV SV				
*15	NBA-S8A		SS SS SS SV SV				
*16	NBA-S8B		SS SS SS SV SV				
*17	NBA-S9A		SS SS SS SV SV				
*18	NBA-S9B		SS SS SS SV SV				
*19	NBA-S10A		SS SS SS SV SV				
*20	NBA-S10B		SS SS SS SV SV				

D-5

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-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

	RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	RECEIVED BY: (NAME/ORGANIZATION/DATE/TIME)
1	George Sullivan \ E.S.E. \ 8-1-86 \ 12:11 p.m.	[illegible] LRB 8-[illegible]-86 1200
2		J Shamo [illegible] 8/4/86 8:15
3		

OTHER FIELD NOTES FOR FIELD GROUP [redacted]: CLUST2

ENVIRONMENTAL SCIENCE & ENGINEERING 07-31-86 *** FIELD LOGSHEET *** FIELD GROUP: CHICS1

PROJECT NUMBER 86401V0418 PROJECT NAME: NAVY - LUST LAB. COORD. JEFF SHAMIS

8/29/86

CHICS1

1400

ESE #	SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST	
*1	P-S	1A	SS SV	4Aug86	1030	CLUST2	Tank P - ~~East~~ South side
*2	P-N	1B	SS SV	4Aug86	~~1030~~	CLUST2	Tank P - North side
*3	P	1C	SS SV	4Aug86	1500	CLUST2	Tank P
*4	L-S	2A	SS SV	5Aug86	0930	CLUST2	Tank L - South side
*5	L-SSW	2B	SS SV	5Aug86	1030	CLUST2	Tank L - SSW
*6	L-N	2C	SS SV	5Aug86	1130	CLUST2	Tank L - North side
*7	K-S	3A	SS SV	5Aug86	1350	CLUST2	Tank K - So. side
*8	K-NW	3B	SS SV	5Aug86	1425	CLUST2	Tank K - NW side
*9	K-E	3C	SS SV	5Aug86	1520	CLUST2	Tank K East side

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-HAZARD CODES: I=IGNITABLE C=CORROSIVE R=REACTIVE T=TOXIC WASTE H=OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

	RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	RECEIVED BY (NAME/ORGANIZATION/DATE/TIME)
1	Susan A. Blinging ESE 5August86 1600	J Shamis ESE 8/6-1220
2		
3		

OTHER FIELD NOTES FOR FIELD GROUP CHICS1:

Note: potential petroleum contamination

8/29

NVIRONMENTAL SCIENCE & ENGINEERING 06-03-86 *** FIELD LOGSHEET *** FIELD GROUP: CLUST1
ROJECT NUMBER 86401V0418 PROJECT NAME: CHARLESTON LUST PROGRAM LAB COORD. JEFF SHAMIS

#	SITE/STA	HAZ?	FRACTIONS(CIRCLE) CLUST1	DATE	TIME	PARAMETER LIST	pH	Cond	Temp
*1.	MW-1		O VP VP VP	8-11-86	1710	CLUST1	7.1	12,600	23.6
*2	MW-2		O VP VP VP	8-11-86	1315	CLUST1	7.9	38,500	23.0
*3	MW-3A		O VP VP VP	8-11-86	1430	CLUST1	7.6	24,300	22.0
*4	MW-3B		O VP VP VP	8-11-86	1305	CLUST1	7.8	22,200	26.3
*5	MW-4		O VP VP VP	8-11-86	1545	CLUST1	8.0	5,350	26.5
*6			O VP VP VP			CLUST1			
*7	MW-6		O VP VP VP	8-11-86	1800	CLUST1	7.7	31,200	21.1
*8			O VP VP VP			CLUST1			
*9			O VP VP VP	[illegible]		CLUST1			
10	MW-5	C	O VP VP VP	8-11-86	1615	CLUST1	7.7	3,800	27.2
11			O VP VP VP			CLUST1			
12			O VP VP VP			CLUST1			
13			O VP VP VP			CLUST1			
14			O VP VP VP			CLUST1			
15			O VP VP VP			CLUST1			
16			O VP VP VP			CLUST1			

D-7

E -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
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-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME) RECEIVED BY (NAME/ORGANIZATION/DATE/TIME)

David Smock /ESE/8-11-86/1835 J Shamis ESE 8/12/86 1130

R FIELD NOTES FOR FIELD GROUP CLUST1:

[redacted] [redacted]

No Dupe (O Fract.) on Sample #1
A Dupe was taken with Sample #10

ENVIRONMENTAL SCIENCE & ENGINEERING 06-03-86 *** FIELD LOGSHEET *** FIELD GROUP: CLUST1 8/29

PROJECT NUMBER 86401V0418 PROJECT NAME: CHARLESTON LUST PROGRAM LAB COORD. JEFF SHAMIS

ESE #	SITE/STA	HAZ?	CLUST1 FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST	Temp	DO	ph	Cond
17 ~~*1~~	SW1		0 ~~VP VP VP~~	12 Aug	1045	CLUST1A	29.4	6.0	21	26000
18 ~~*2~~	SW2		0 VP ~~VP VP~~	12 Aug	1035	CLUST1A	28.5	6.4	24	27900
19 ~~*3~~	SW3		0 ~~VP VP VP~~	12 Aug	1045	CLUST1A	27.7	6.8	6.5	25700
*4			0 VP VP VP			CLUST1				
*5			0 VP VP VP			CLUST1				
*6			0 VP VP VP			CLUST1				
*7			0 VP VP VP			CLUST1				
*8			0 VP VP VP			CLUST1				
*9			0 VP VP VP			CLUST1				
*10			0 VP VP VP			CLUST1				
*11			0 VP VP VP			CLUST1				
*12			0 VP VP VP			CLUST1				
*13			0 VP VP VP			CLUST1				
*14			0 VP VP VP			CLUST1				
*15			0 VP VP VP			CLUST1				
*16			0 VP VP VP			CLUST1				

AE sample of surface water for CLUST. Call Rob for further details.

D-8

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-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

	RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	RECEIVED BY (NAME/ORGANIZATION/DATE/TIME)
1	Robert A. Bur / ESE / 12 Aug 86 / 1650	J. Shamis 8/13/86 ESE
2		
3		8/29/86

OTHER FIELD NOTES FOR FIELD GROUP CLUST1:

O's received unpreserved - JS

ENVIRONMENTAL SCIENCE & ENGINEERING 05-13-87 *** FIELD LOGSHEET *** FIELD GROUP: NLUST2
PROJECT NUMBER 87407V0212 PROJECT NAME: CHARLESTON LUST - NAVY LAB COORD. LISA BARE

6/19/87

NLUST2

SE #	SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST	H2O TEMP C	FIELD PH STD UNITS	SP COND UMHOS/CM
*1	3A (prob)		LC LC O O VP VP VP VP	18 May 87	1220	NLUST2	22.6	6.9	24,600
*2	3B (prob)		LC LC O O VP VP VP VP	18 May 87	1240	NLUST2	22.5	7.0	21,000
*3	MW4		LC LC O O VP VP VP VP	18 May 87	1345	NLUST2	21.6	7.6	5,881
*4	MW2		LC LC O O VP VP VP VP	18 May 87	1400	NLUST2	21.8	7.1	33,500
*5	MW5		LC LC O O VP VP VP VP	18 May 87	1445	NLUST2	23.1	7.1	3050
*6	MW1		LC LC O O VP VP VP VP	18 May 87	1615	NLUST2	23.2	5.3	9,750
*7			LC LC O O VP VP VP VP			NLUST2			
*8			LC LC O O VP VP VP VP			NLUST2			

cooler 1

cooler 2

D-9

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-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

	RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	RECEIVED BY (NAME/ORGANIZATION/DATE/TIME)
1	Robert R. Burke/ESE, INC/18 May 87/1800	[illegible] ESE 5/19/87 1400
2		
3		

OTHER FIELD NOTES FOR FIELD GROUP NLUST2:

Trip Blank included

→ Log sheet for 2 coolers!

(short of sheets!)

ENVIRONMENTAL SCIENCE & ENGINEERING 05-13-87 *** FIELD LOGSHEET *** FIELD GROUP: NLUST2

PROJECT NUMBER 87407V0212 PROJECT NAME: CHARLESTON LUST - NAVY LAB COORD. LISA BARE

SE #	SITE/STA	HAZ?	NLUST2 FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST	H2O TEMP C	FIELD PH STD UNITS	SP COND UMHOS/CM	
*1			LC LC O O VP VP VP VP			NLUST2				
*2			LC LC O O VP VP VP VP			NLUST2				
*3			LC LC O O VP VP VP VP			NLUST2				
*4			LC LC O O VP VP VP VP			NLUST2				
*5			LC LC O O VP VP VP VP			NLUST2				
*6			LC LC O O VP VP VP VP			NLUST2				
*7	MW-6		LC LC O O VP VP VP VP	19 May 87	0910	NLUST2	22.1	6.3	25,600	
*8	DUP		LC LC O O VP VP VP VP	19 May 87	0910	NLUST2	22.1	6.3	25,600	DUP

D-10

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-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN LOGSHEETS WITH SAMPLES TO ESE

	RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	RECEIVED BY (NAME/ORGANIZATION/DATE/TIME)
1	Robert R. Burke/ESE/19 May 87/1800	[illegible] ESE 5/20/87 1400
2		
3		

OTHER FIELD NOTES FOR FIELD GROUP NLUST2:

Trip Blank included!

* note strong reaction when Sulfuric acid added - heavy "foaming" reaction.